Supplementary Materials for

# Vanishing volcanics: Implications of mass wasting deposit sediment heterogeneity on downstream abrasion and the fluvial hazard cascade

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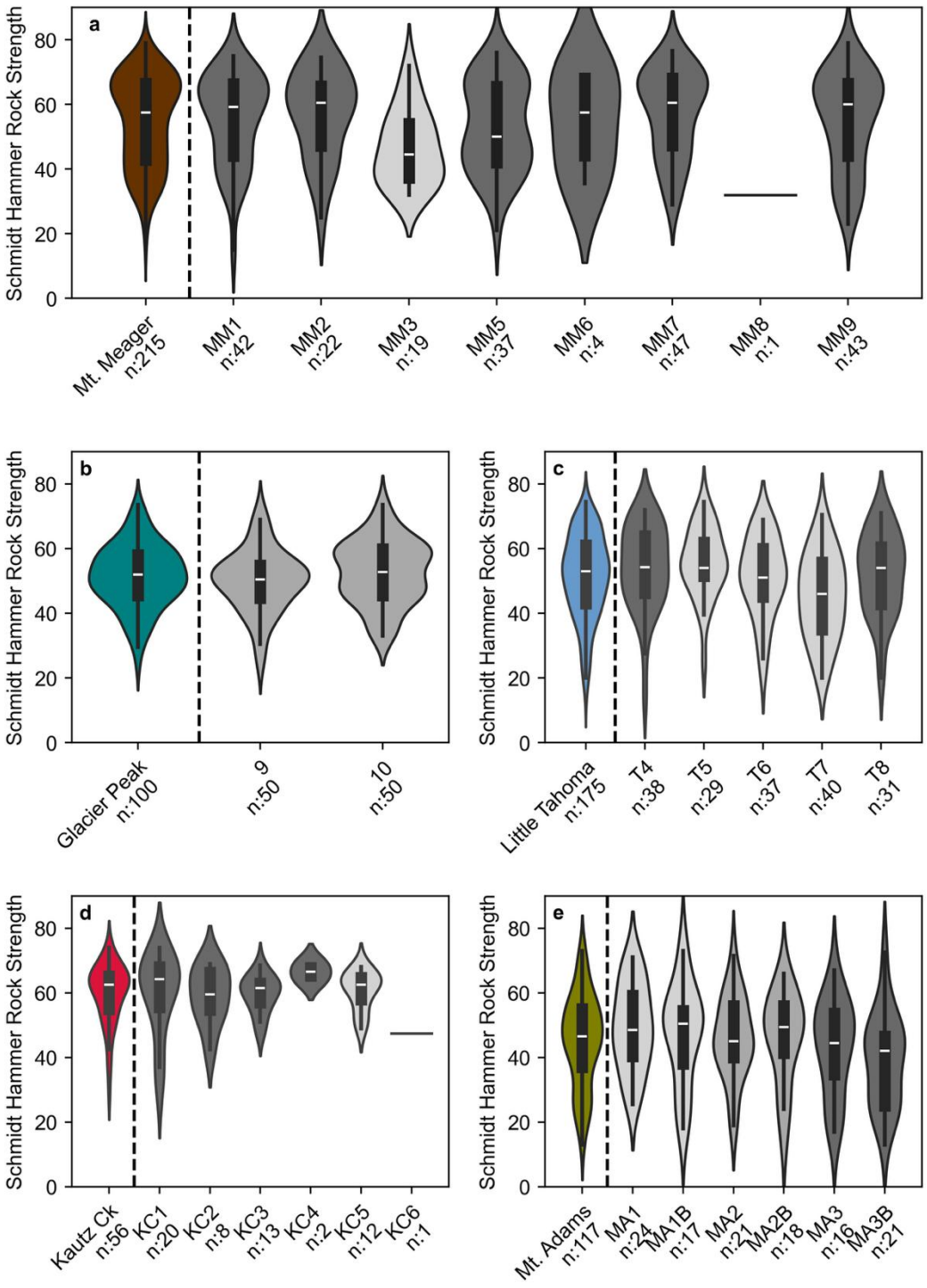


**Figure S1.** SHRS of each deposit, broken up by exposure. The site-cumulative SHRS distributions shown here are not corrected for the relative proportions of lithologies found in the deposits. Those modeled/weighted proportions are shown in Figure 4. MM4, 10, 11, KC7 have n=0 and are removed.

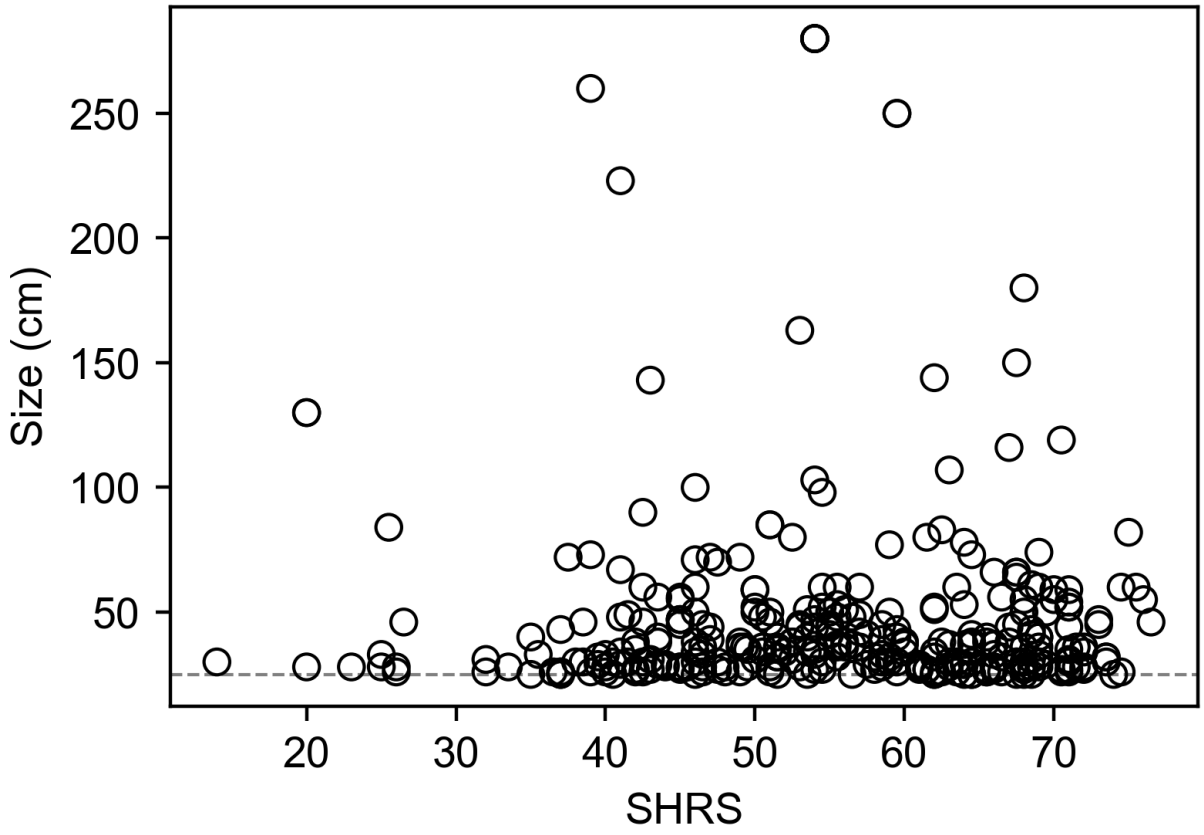


**Figure S2.** Clast size vs strength for measured clasts ≥25 cm. Dashed line denotes 25 cm.

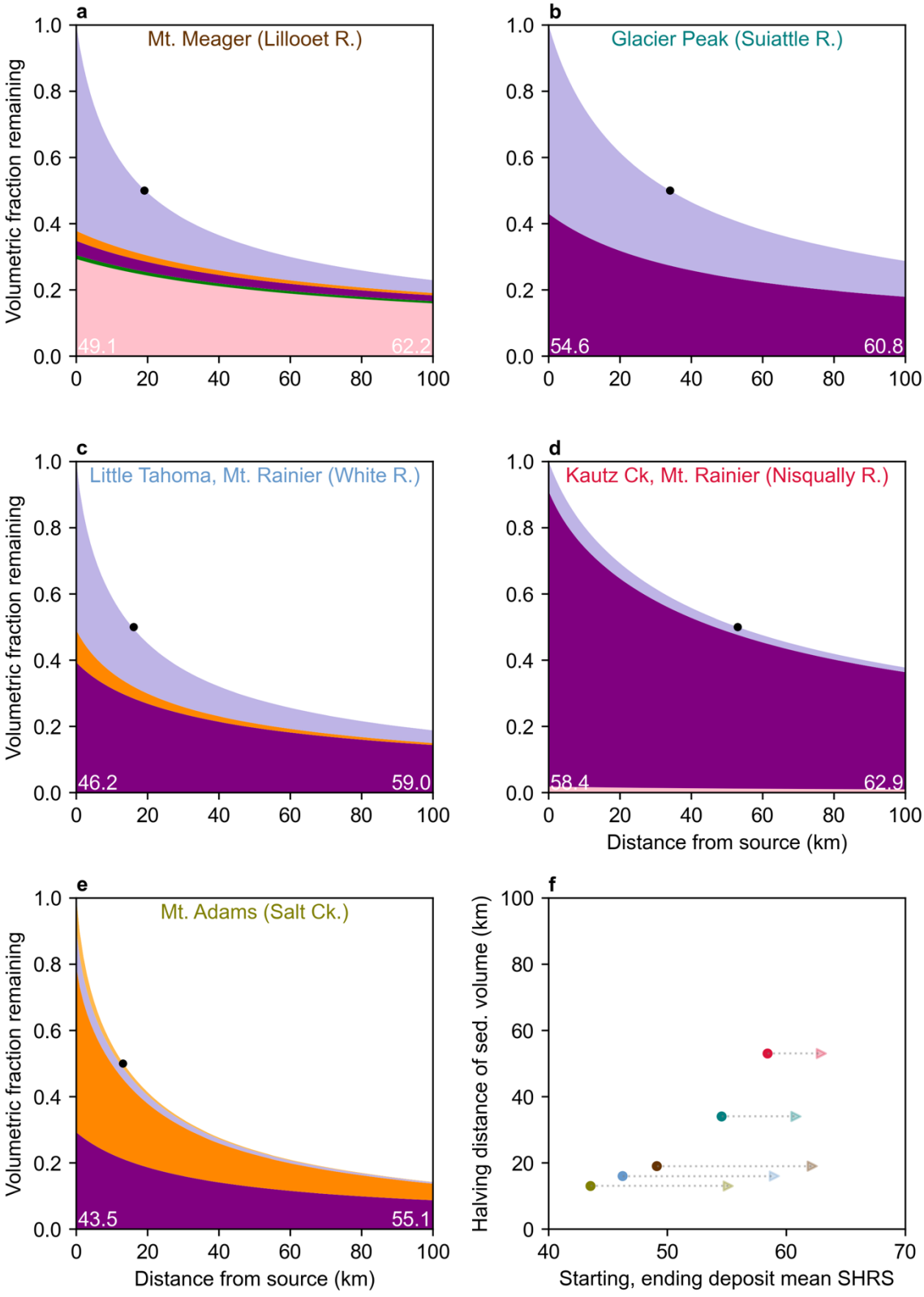


**Figure S3.** Sensitivity analysis of modeled abrasion for all sites using the small GSD from Mt. Adams. Colors as in Figure 7.

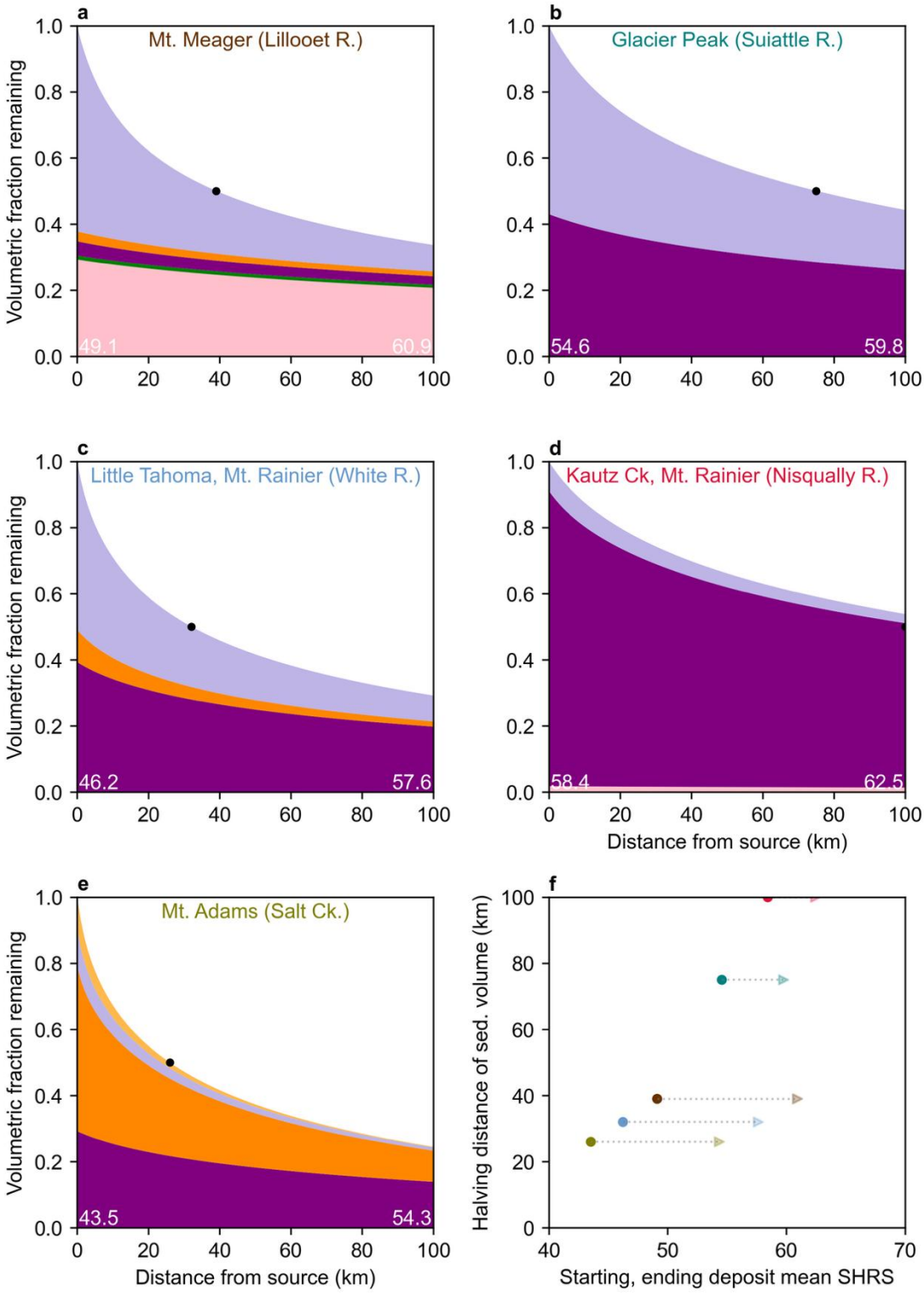


**Figure S4**. Sensitivity analysis of modeled abrasion for all sites using the large pulse GSD from Glacier Peak (Suiattle River). Colors as in Figure 7.

## Supplementary Tables

**Table S1.** Lithologic classifications for each deposit.

| Dep | Lith | Deposit Specific Lithology | Sample |
|---|---|---|---|
| Mt. Meager (Lillooet River) | V | LDV – Low-Density Volcanic: millimeter to centimeter scale vesicles on a continuum, matrix with phenocrysts, sometimes needle shaped, gray to red. |  |
| | NA | OW – Orange Weathered: white and orange with liesegang banding, hydrothermal alteration. |  |
| | N | HDV – High Density Volcanic: dense, aphanitic, dark grey to black. |  |
| | P | P – Plutonic: intrusive crystalline rock. |  |
| | M | HGM – High Grade Metamorphic: crystalline rock with some banding. |  |
| Glacier Peak (Suiattle River) | V | VV – Vesicular Volcanic: tiny millimeter scale vesicles visible in clean face, porphyritic white and black crystals with gray and red ground mass. |  |
| | N | NV – Non-Vesicular Volcanic: dense, porphyritic white crystals, dark gray to black ground mass. |  |
| | P | P – Plutonic Crystalline: intrusive crystalline rock, white and pink with white, pink, and green crystals. |  |

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| Dep | Lith | Deposit Specific Lithology | Sample |
|---|---|---|---|
| Mt. Rainier (White River) | V | VV – Vesicular Volcanic: obvious larger than millimeter scale vesicles, noticeably lighter in weight and often weathered. |  |
| | V | TV – Tiny Vesicular: tiny millimeter scale vesicles that could be seen in a clean face, porphyritic, often weathered. |  |
| | NA | WW - White Weathered: crystalline rock, visible crystals hydrothermally altered to green, brown, gray, and white clays. |  |
| | N | PN – Porporhyritic Non-Vesicular: dense, dark grey to black ground ground mass with white phenocrysts. |  |
| Mt. Rainier (Kautz Creek) | V | V – Vesicular: visible mm to cm vesicles in gray, black, and red ground mass with white phenocrysts. |  |
| | N | NV – Non-Vesicular: none to very few visible vesicles, gray to black andesite with white phenocrysts and some surficial weathering rind. |  |
| | P | P – Plutonic: intrusive crystalline rock with white, pink, and green crystals. |  |

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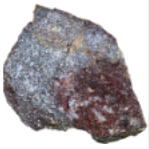
| Dep | Lith | Deposit Specific Lithology | Sample |
|---|---|---|---|
| Mt. Adams (Salt Creek) | VA | VA – Vesicular Altered: visible mm to cm vesicles in altered ground mass light gray, yellow, purple, pink and red with white phenocrysts, hydrothermal alteration. |  |
| | NA | NA – Non-Vesicular Altered: none to very few visible vesicles, white phenocrysts, color varies light gray, purple, pink, red, and orange, hydrothermal alteration. |  |
| | V | VN – Vesicular Non-Altered: visible mm to cm vesicles in gray to black ground mass with white phenocrysts. |  |
| | N | NN – Non-Vesicular Non-Altered: none to very few visible vesicles, gray to black andesite with white phenocrysts and some surficial weathering rind. |  |

**Table S2.** Lithology fractions of each exposure from the 5 study deposits.

| *Deposit* | *Exposure* | *Fines %* | *Lithology % (Coarse Fraction)* | | | | |
|---|---|---|---|---|---|---|---|
| **Mt. Meager (Lillooet River)** | | | *LDV* | *OW* | *HDV* | *PL* | *HGM* |
| | Deposit | 19.5 | 62.2 | 3.0 | 5.4 | 29.3 | 1.2 |
| | MM1 | 17.0 | 57.8 | 3.6 | 7.2 | 28.9 | 2.4 |
| | MM2 | 25.6 | 68.7 | 1.1 | 7.9 | 22.5 | 1.1 |
| | MM3 | 8.6 | 66.4 | 0.9 | 2.8 | 29.0 | 0.9 |
| | MM4 | 29.3 | 58.5 | 7.4 | | 34.1 | |
| | MM5 | 22.0 | 64.6 | | 6.3 | 29.1 | |
| | MM6 | 8.9 | 51.2 | 4.9 | 7.3 | 36.6 | |
| | MM7 | 32.0 | 51.5 | 2.9 | 2.9 | 42.7 | 1.5 |
| | MM8 | 17.7 | 58.9 | 4.5 | 6.3 | 29.5 | 0.9 |
| | MM9 | 20.5 | 56.2 | 4.5 | 3.4 | 34.8 | 1.1 |
| | MM10 | 21.4 | 95.5 | | | 4.6 | |
| | MM11 | 23.5 | 87.2 | | 2.5 | 10.4 | |
| **Glacier Peak (Suiattle River)** | | | *VV* | *NV* | *PL* | | |
| | Deposit | 21.1 | 56.1 | 42.1 | 1.8 | | |
| | 7 | 20.4 | 38.5 | 53.9 | 7.7 | | |
| | 7.5 | 6.0 | 51.1 | 48.9 | | | |
| | 9 | 26.6 | 57.5 | 42.5 | | | |
| | 10 | 3.2 | 61.5 | 37.3 | 1.2 | | |
| | 11 | 44.9 | 63.3 | 34.7 | 2.0 | | |
| **Mt. Rainier (White River)** | | | *VV* | *TV* | *WW* | *PN* | |
| | Deposit | 15.4 | 19.1 | 31.9 | 9.7 | 39.3 | |
| | T4 | 31.3 | 6.3 | 10.5 | 31.8 | 51.5 | |
| | T5 | 13.8 | 6.0 | 47.3 | | 46.7 | |
| | T6 | 10.3 | 20.6 | 36.1 | 13.0 | 30.3 | |
| | T7 | 16.0 | 51.0 | 15.0 | 5.0 | 29.0 | |
| | T8 | 9.8 | 14.6 | 34.6 | 10.0 | 40.9 | |

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**Table S2.** Continued.

| *Deposit* | *Exposure* | *Fines %* | *Lithology % (Coarse Fraction)* | | | |
|---|---|---|---|---|---|---|
| **Mt. Rainier (Kautz Creek)** | | | *V* | *NV* | *PL* | |
| | Deposit | 53.5 | 9.0 | 89.2 | 1.8 | |
| | KC1 | 42.2 | 3.9 | 92.3 | 3.9 | |
| | KC2 | 44.1 | | 100.0 | | |
| | KC3 | 40.0 | 20.0 | 76.7 | 3.3 | |
| | KC4 | 63.6 | 6.7 | 93.3 | | |
| | KC5 | 44.2 | 8.6 | 90.9 | 0.5 | |
| | KC6 | 68.2 | 14.8 | 85.2 | | |
| | KC7 | 71.1 | 4.2 | 91.7 | 4.2 | |
| **Mt. Adams (Salt Creek)** | | | *VA* | *NA* | *V* | *N* |
| | Deposit | 44.1 | 9.8 | 49.8 | 11.1 | 29.2 |
| | MA1 | 51.0 | 6.3 | 35.4 | 12.5 | 45.8 |
| | MA1B | 48.0 | 7.6 | 45.3 | 7.6 | 39.6 |
| | MA2 | 51.0 | 17.0 | 51.3 | 10.4 | 21.3 |
| | MA2B | 35.0 | 9.0 | 62.7 | 9.0 | 19.4 |
| | MA3 | 44.4 | 7.3 | 41.8 | 18.2 | 32.7 |
| | MA3B | 44.4 | 12.7 | 58.2 | 9.1 | 20.0 |

**Table S3.** Observed SHRS statistics and modeled SHRS statistics for Figure 4.

| | *Deposit* | *Min* | *25% Quartile* | *Median* | *75% Quartile* | *Max* |
|---|---|---|---|---|---|---|
| Observed | Lillooet River | 15.0 | 42.75 | 57.5 | 66.50 | 79.0 |
| | Suiattle River | 24.0 | 45.50 | 52.0 | 58.00 | 73.5 |
| | White River | 14.0 | 43.00 | 53.0 | 61.00 | 74.5 |
| | Kautz Creek | 29.0 | 54.88 | 62.5 | 65.12 | 74.0 |
| | Salt Creek | 13.0 | 37.00 | 46.5 | 55.00 | 73.0 |
| Modeled | Lillooet River | 15.0 | 38.0 | 47.1 | 62.0 | 77.5 |
| | Suiattle River | 24.0 | 48.7 | 54.4 | 60.9 | 73.4 |
| | White River | 14.0 | 38.0 | 46.2 | 55.5 | 73.4 |
| | Kautz Creek | 29.0 | 54.5 | 62.0 | 64.9 | 73.6 |
| | Salt Creek | 13.0 | 37.0 | 46.0 | 52.2 | 73.0 |

**Table S4.** Grain size distributions.

| *Deposit* | *Exposure* | *% Fines* | *D16 (m)* | *D50 (m)* | *D95 (m)* |
|---|---|---|---|---|---|
| **Mt. Meager (Lillooet River)** | | **19.48** | **0.007** | **0.020** | **0.200** |
| | MM1 | 17.00 | 0.005 | 0.020 | 0.189 |
| | MM2 | 25.62 | 0.006 | 0.020 | 0.192 |
| | MM3 | 8.55 | 0.010 | 0.030 | 0.199 |
| | MM4 | 29.31 | 0.005 | 0.010 | 0.100 |
| | MM5 | 21.95 | 0.010 | 0.040 | 0.462 |
| | MM6 | 8.89 | 0.008 | 0.025 | 0.176 |
| | MM7 | 32.00 | 0.005 | 0.020 | 0.515 |
| | MM8 | 16.91 | 0.007 | 0.018 | 0.100 |
| | MM9 | 20.54 | 0.005 | 0.020 | 0.160 |
| | MM10 | 21.43 | 0.010 | 0.015 | 0.089 |
| | MM11 | 23.53 | 0.010 | 0.020 | 0.081 |
| **Glacier Peak (Suiattle River)** | | **21.10** | **0.030** | **0.090** | **0.512** |
| | 10 | 3.19 | 0.030 | 0.070 | 0.390 |
| | 7.5 | 6.00 | 0.030 | 0.110 | 1.300 |
| | 7 | 20.41 | 0.040 | 0.070 | 0.500 |
| | 9 | 26.56 | 0.022 | 0.075 | 0.540 |
| | 11 | 44.94 | 0.040 | 0.130 | 0.530 |
| **Mt. Rainier (White River)** | | **15.23** | **0.015** | **0.070** | **0.720** |
| | T4 | 30.61 | 0.015 | 0.090 | 2.600 |
| | T5 | 13.79 | 0.015 | 0.080 | 0.728 |
| | T6 | 10.29 | 0.015 | 0.065 | 0.470 |
| | T7 | 15.97 | 0.010 | 0.060 | 0.471 |
| | T8 | 9.76 | 0.010 | 0.080 | 0.665 |
| **Mt. Rainier (Kautz Creek)** | | **53.51** | **0.015** | **0.070** | **0.830** |
| | KC1 | 42.22 | 0.015 | 0.070 | 0.265 |
| | KC2 | 42.86 | 0.090 | 0.225 | 0.536 |
| | KC3 | 39.22 | 0.100 | 0.220 | 0.510 |
| | KC4 | 63.64 | 0.024 | 0.150 | 0.308 |
| | KC5 | 44.22 | 0.012 | 0.038 | 1.782 |
| | KC6 | 68.24 | 0.011 | 0.030 | 0.180 |
| | KC7 | 70.13 | 0.010 | 0.015 | 0.067 |
| **Mt. Adams (Salt Creek)** | | **44.08** | **0.005** | **0.015** | **0.280** |
| | MA1 | 50.00 | 0.007 | 0.030 | 0.418 |
| | MA1B | 47.57 | 0.010 | 0.020 | 0.315 |
| | MA2 | 49.00 | 0.005 | 0.015 | 0.400 |
| | MA2B | 33.64 | 0.005 | 0.012 | 0.165 |
| | MA3 | 42.31 | 0.005 | 0.015 | 0.242 |
| | MA3B | 42.72 | 0.006 | 0.020 | 0.141 |

**Table S5.** $D_{84}/D_{50}$ ratios for each deposit.

| *Deposit* | $D_{84}/D_{50}$ |
|---|---|
| Mt. Meager (Lillooet River) | 4.00 |
| Glacier Peak (Suiattle River) | 3.78 |
| Mt. Rainier (White River) | 4.14 |
| Mt. Rainier (Kautz Creek) | 5.31 |
| Mt. Adams (White Salmon River) | 8.00 |