**Young et al. "Assessing climatic and non-climatic forcing of Pinedale glaciation and deglaciation in the western US" Data Repository Item**

*Pinedale nomenclature*

The name 'Pinedale' historically refers to end moraines at the type locality in Pinedale, Wyoming, corresponding to the maximum phase of marine oxygen isotope stage 2 glaciation (Blackwelder, 1915; Gosse et al., 1995a). Initially, moraines across the western US were correlated to the type deposits by relative dating criteria. However, detailed numerical dating has since revealed that many moraines originally referred to as 'Pinedale' are not actually the same age as the terminal moraines at the type locality. Here, we use the name 'Pinedale' in reference to terminal and recessional moraines in the western US that are of marine oxygen isotope stage 2 age.

*Upper Arkansas River valley glacial geomorphology*

The Upper Arkansas valley in central Colorado encompasses the headwaters for the Arkansas River, which drains the Mosquito Range situated to the east and the Sawatch Range to the west. Bedrock in the region is composed primarily of Precambrian plutonic and metamorphic rocks (granites and gneisses), with exposures of late Cretaceous and Tertiary plutonic rocks (Tweto et al., 1976; 1978; Scott et al., 1978). During the latest Pleistocene glaciation (e.g. Pinedale), Sawatch Range glaciers extended eastward towards the north-south trending upper Arkansas River valley. Notably, glaciers that flowed down Lake Creek, Clear Creek, and Pine Creek valleys extended beyond the range front and onto the Upper Arkansas valley floor, depositing large latero-frontal moraines.

Initial work in the area identified four flood terraces along the Arkansas River south of Pine Creek (Scott, 1975, 1984). Terraces were tentatively correlated to glacier maxima and subsequent outburst floods occurring during the early Pleistocene (uppermost terrace), middle Pleistocene, and late Pleistocene (two lowermost terraces; Scott, 1984). The age of the uppermost terrace is constrained by an outcrop of alluvium containing flood boulders, which is correlated to a surface ~20 km away containing Bishop Ash (~760 ka; Sarna-Wojcicki et al., 2000). Tributary alluvial fans sourced from the Mosquito Range, containing Lava Creek B ash (~640 ka; Lanphere et al., 2002), are correlated with the next highest flood deposit (Scott, 1984). The two lower terraces lie within Pinedale-age outwash and are strewn with large boulders, almost all of which are composed of granodiorite (Scott, 1975); smaller clasts are composed of both granodiorite and metamorphic lithologies. These boulders were likely dislodged from moraines and valley walls during flooding. We only focused on the lowest two terraces of the four (i.e., the late Pleistocene terraces), which we refer to in the text as higher and lower.

*Upper Arkansas River valley $^{10}Be$ ages*

Samples from flood terraces (*n* = 8), the Clear Creek Pinedale terminal moraine (*n* =5), and glacial-sculpted bedrock surfaces up-valley from moraines in Pine Creek and Lake Creek valleys (*n* = 6) were collected with hammer and chisel. Sampled boulders on the Clear Creek moraine were all >1 m in height and sampled terrace boulders were at least 1.5 m tall (Fig. DR1). At all locations, samples were collected from horizontal to near-horizontal surfaces and we avoided sampling from boulder edges and corners. Geographic coordinates and sample elevation were collected with a handheld GPS unit and a clinometer was used to measure shielding by the surrounding topography.

All samples were processed at the University at Buffalo Cosmogenic Isotope Laboratory. Quartz was isolated from bulk samples following procedures modified from Kohl and Nishiizumi (1992). Samples were first crushed and sieved to isolate the 425-850 μm size fraction and then pretreated in dilute HCl and $HNO_3$-HF acid baths. Quartz (~16-35 g) was isolated by heavy-liquid mineral separation and additional $HNO_3$-HF heated sonification baths. $^{9}$Be carrier (~250- 350 μg; SPEX 1000 μg/g) was added to each sample prior to digestion in concentrated HF. Beryllium was extracted using ion-exchange chromatography, selective precipitation with $NH_4OH$, and final oxidation to BeO.

$^{10}$Be/$^{9}$Be AMS measurements were completed at the Purdue Rare Isotope Measurement (PRIME) Laboratory and Lawrence Livermore National Laboratory Center for Mass Spectrometry (LLNL-CAMS). Samples measured at both PRIME lab (*n* = 11) and LLNL-CAMS (*n* = 8), were normalized to 07KNSTD standard reference material (Nishiizumi et al., 2007). $^{10}$Be/$^{9}$Be ratios for process blanks (*n* = 3) averaged $1.80 \times 10^{-14} \pm 1.38 \times 10^{-14}$. AMS precision for blank-corrected $^{10}$Be/$^{9}$Be sample ratios ranged from 2.0-4.6%.

$^{10}$Be exposure ages (Tables DR1 and 2) were calculated using the CRONUS-Earth online exposure age calculator (http://hess.ess.washington.edu/ math; Version 2.2; Balco et al., 2008). Ages were calculated using the global reference $^{10}$Be production rate (PR) of 4.49 ± 0.39 atoms $g^{-1}$ $yr^{-1}$ and the non-time-dependent production scaling scheme of Lal (1991)/Stone (2000). All ages are presented in ka with 1σ uncertainty. This updated PR reflects a normalization of $^{10}$Be calibration material to the 07KNSTD standard (Nishiizumi et al., 2007). We use the global PR and Lal/Stone (St) scaling primarily to be consistent with previously published $^{10}$Be ages from the western US. $^{10}$Be ages calculated with alternative scaling schemes that incorporate time-dependent production rates based on fluctuations in the Earth's magnetic field are presented in Table DR2. To further ensure consistency with other western US $^{10}$Be chronologies, $^{10}$Be ages are not corrected for the effects of snow cover or erosion. However, we note that samples were collected at windswept locations and rock surfaces displayed little evidence of surface weathering; we consider the effects of both snow cover and erosion to be minimal.

*Arkansas River valley paleoglaciers*

Ice-surface contours of paleo-glaciers in the Arkansas River valley were reconstructed by digitizing the areal extent of each paleo-glacier from the cirque headwall to the Pinedale terminal moraine on 1:24,000 scale USGS topographic maps. We follow previously established methods (e.g. Porter, 1975; Leonard, 1984; Brugger and Goldstein, 1999) and make general assumptions regarding ice-surface contour shape in the accumulation and ablation areas (Figure DR3). From the paleoglacier surface reconstructions, we calculated hypsometry, plotted as area-altitude distributions, determined by calculating glacier surface area between successive ice-surface contours (Figure DR4). To estimate paleo-equilibrium-line-altitudes (ELA), we use an accumulation-area ratio of 0.65±0.05, which is a commonly used value and has been used nearby in Colorado (Meir and Post, 1962; Andrews and Miller, 1972; Leonard, 1984, Brugger and Goldstein, 1999). Reconstructed ELAs for Lake Creek, Clear Creek, and Pine Creek valleys are 3350 +64/-183 m (10,990 +210/-600 ft), 3232 + 72/- 149 m (10,605 +235/-490 ft), and 3315+99/-70 m. (10,875 +325/-230 ft ), respectively (Figure DR4). Uncertainty values are derived from ELA reconstructions using AAR values of 0.6 (+) and 0.7 (-).

*Compilation and recalculation of $^{10}$Be ages from Pinedale moraines across the western US*

We compiled sample information for 180 surface exposure ages across the western US (Table DR1); all but two ($^{26}$Al) are $^{10}$Be ages. Because PRs and scaling schemes are constantly being updated, all $^{10}$Be ages were recalculated using the global PR and St scaling, before comparing our upper Arkansas River basin chronology to other western US chronologies. Recalculated $^{10}$Be ages match those for recently published western US $^{10}$Be ages that use the global PR and St scaling. In some cases, recalculated $^{10}$Be ages were ~2-3% older than originally published values, which is due to a slight reduction of the global PR (i.e. 5.1 to 4.96 atoms $g^{-1}yr^{-1}$) since publication of the original $^{10}$Be ages. We also provide western US $^{10}$Be ages calculated with different scaling schemes (Table DR2).

We recognize that newly emerging, regionally-calibrated, $^{10}$Be production rates are considerably lower (6 to 12%) than the global PR (e.g. Balco et al., 2009; Putnam et al., 2010) and that use of a lower PR would increase $^{10}$Be ages. In light of this, $^{10}$Be ages using the Northeast North America production rate (e.g. Balco et al., 2009) and the Lifton et al. (2005) scaling scheme (Table DR2; NE Li) are also reported. We present the Li scaling scheme because nuclide production rates in the Li scaling scheme rely strongly on elevation (e.g. Balco et al., 2008) and may be the most suitable to the relatively high elevations of Pinedale sample localities. $^{10}$Be ages calculated with these parameters change $^{10}$Be ages calculated with the global PR and St scaling by -2 to +9%. Finally, Table DR1 provides all of the necessary input values in which to recalculate western US surface exposure ages on the CRONUS website.

*Comparing chronologies of glaciation and deglaciation*

Prior to comparing western US chronologies, all $^{10}$Be ages were re-calculated using the same parameters (Tables DR1 and DR2) and then plotted against the normalized glacier length of each respective glacier system (Fig. 3; Table DR3).

Glacier length at each location, including valleys within the Arkansas River drainage basin, was determined by measuring the distance between the cirque headwall and each dated ice margin position (Table DR3). In valleys with multiple drainages and cirques, we only measured the distance between the dated ice-margin position and the cirque in which the timing of deglaciation is constrained. Below, we briefly summarize the chronological constraints of Pinedale and equivalent moraines and valley deglaciation used in our compilation.

Three studies from Colorado and Utah meet the aforementioned criteria. Guido et al. (2007) dated the Pinedale maximum ice extent in the Animas River valley, southwestern CO, to 19.4±1.5 ka, and Ward et al. (2009) present 4 ages from the Pinedale terminal moraine in the Middle Boulder Creek valley in the Colorado Front Range that average 20.3±2.1 ka. Subsequent retreat of both valley glaciers was constrained by dating a transect of glacially-sculpted bedrock samples. The upper 75% of the Animas River valley deglaciated between 15.1 and 12.3 ka ($n$=5) and the uppermost 64% of the Middle Boulder Creek valley deglaciated between 13.8 and 12 ka ($n$=10). In the western Uinta Mountains, Utah, ice remained at its Pinedale maximum limit until 15.8±2.5 ka (mean of 8 moraine boulders), and sculpted bedrock from the ice divide indicate final deglaciation at 14.3±0.4 ka ($n$=4; Refsnider et al., 2008), indicating complete deglaciation took place between ~15.8 and ~14.3 ka.

Using our criteria, four studies were selected from Wyoming, the Yellowstone region, and northeastern Oregon. In the Wind River Range, WY, Gosse et al. (1995a, b) dated dozens of boulders from a belt of moraines near Fremont Lake, as well as moraine boulders close to the cirque head in the Titcomb Lakes basin. $^{10}$Be ages from the terminal moraine average 23.9±1.1 ka; the innermost recessional moraine near Fremont Lake dates to 17.9±1.4 ka (which lies at 94% of the maximum Pinedale glacier length; below, we list glacier-length fractions associated with each dated location). Farther upvalley, the Titcomb Lakes moraine is dated to 12.7±0.5 ka (12%), and boulders just beyond the moraine average 14.0±1.2 ka (13%); combined, these data from the Wind River Range indicate that the valley glacier retreated from 94 to 13% of its Pinedale maximum length between ~17.9 and ~14 ka. At the northwestern margin of the Yellowstone Ice Cap, a terminal moraine and inboard end moraine date to 16.5±1.4 ka (100%) and 16.1±1.7 ka (94%), respectively (Licciardi et al., 2001; Licciardi and Pierce, 2008). Closer to the ice divide in the same sector of the Yellowstone Ice Cap are moraines (Deckard Flats; Junction Butte) dated at 14.2±1.2 ka (48%) and 14.2±0.4 ka (21%; younger mode of a bimodal age distribution), indicating that ice retreated from 94 to 21% of its Pinedale maximum length between ~16.1 and ~14.2 ka. However, once the local ELA rose above the relatively broad ice cap plateau, ice loss may have occurred quickly (Pierce, 1979); this change may be exaggerated in the glacial chronology. In the Teton Range, $^{10}$Be ages from Pinedale end moraines at Jenny Lake are 14.6±0.7 ka (100%) and 13.5±1.1 ka (99%), although it is unclear if these moraines represent the maximum Pinedale extent (Licciardi and Pierce, 2008). Ages for deglaciation upvalley from Jenny Lake are 14.8±0.2 ka (79%), 13.8±0.3 ka (22%) and 12.8±0.6 ka (13%), indicating rapid deglaciation of the valley between ~14.8 and ~12.8 ka. In the Wallowa Mountains, northeastern Oregon, $^{10}$Be ages from the Pinedale terminal moraine average 21.8±0.9 ka (Licciardi et al., 2004). End moraines upvalley from the terminal moraine date to 16.9±0.2 ka (96%) and 17.3±0.9 ka (93%), and the glacier was occupying just the cirque by 11.2±1.3 ka (1%), indicating near-complete deglaciation between ~17 and ~11.2 ka.

Outside of the Rocky Mountains, additional studies in the Washington Cascades and the Sierra Nevada meet our criteria. In Icicle Creek, the terminal moraine and adjacent end moraine are 19.1±3.0 ka (100%) and 16.1±1.1 ka (97%), respectively (Porter and Swanson, 2008). Farther up-valley, end moraines date to 13.3±0.8 ka (36%) and 12.5±0.5 ka (33%), indicating that the majority of the Icicle Creek valley was deglaciated between ~16.1 and ~13.3 ka. In the eastern Sierra Nevada, the Tioga glaciation (Pinedale equivalent) is mapped as a four-fold moraine sequence spanning from ~27 to ~15 ka (Clark and Gillespie, 1997; Phillips et al., 2009). Most relevant here is that during the youngest (Tioga-4) phase, glaciers remained at ~65-80% of their Tioga maximum length until 14.9±1.9 ka [average of Tioga-4 $^{36}$Cl ages reported by Phillips et al., (1996, 2009)]. Subsequent deglaciation is based on the age of the Recess Peak cirque glacier advance, when glaciers were 5-15% of their Tioga maximum extents just prior to ~13 ka (Clark and Gillespie, 1997), and $^{36}$Cl ages from between Recess Peak and Tioga 4 moraines, which average 13.8±1.0 ka (Phillips et al., 2009). Thus, the upper 65-80% of eastern Sierra Nevada valleys rapidly deglaciated between ~14.9 and ~13 ka.

*The graphic compilation (Figure 3, main text)*

We make several assumptions in order to plot the ages in Figure 3 (main text). (1) We exclude one old outlier (Molas Lake sample) from the Animas River dataset, consistent with original interpretation by Guido et al. (2007). (2) From Middle Boulder Creek, only ages from the main valley are used. Although four $^{10}$Be ages from a tributary valley suggest that it may have completely deglaciated ~16.0±0.3 ka (Ward et al., 2009), at least one of the four $^{10}$Be ages from the tributary is interpreted to have inheritance. In addition, because there are only a few ages from the tributary, we only plot the transect of ages from the main valley on Figure 3. Furthermore, we average the 6 bedrock ages from the northern tributary cirque and plot as one position (Ward et al., 2009). (3) In the northwest Yellowstone area, the innermost moraine dated (Junction Butte) has two modes, the older of which is older than the Deckard Flats moraine ~30 km down ice-flowline (Licciardi and Pierce, 2008). Thus, we plotted the younger mode of the Junction Butte moraine on Figure 3. (4) The Pinedale terminal moraine in the northwest Yellowstone region was also dated with $^{3}$He, which yields an average age of 16.6±1.3 ka ($^{10}$Be age = 16.5±1.4 ka); we only show the average $^{10}$Be age in Figure 3. (5) For the dataset from Fremont Lakes, Wind River Range, we plot the average ages from each individual moraine crest shown in figure 1 in Gosse et al. (1995a). (6) We excluded one old outlier (17.0±0.5 ka) of the four erratics outboard of the Titcomb Lakes moraines (Gosse et al., 1995b). (7) The Icicle Creek (Porter and Swanson, 2008) and Bishop Creek samples (see Phillips et al., 2009) are $^{36}$Cl ages; we did no recalculations of these, and report what the authors originally reported. See Phillips et al. (2009) for a discussion of $^{36}$Cl production rates. (8). To obtain the average age of the Tioga 4 moraine, we calculated an average of all Tioga 4 moraine boulder $^{36}Cl$ ages reported by Phillips et al. (1996, 2009), which includes moraines at Bloody Canyon, Little McGee Creek, Chiatovich Creek, and Bishop Creek. (9) Phillips et al. (2009) report several $^{36}Cl$ ages from glacially-sculpted bedrock between Tioga 4 moraines and Recess Peak moraines; because there is no trend in the ages (Phillips et al., 2009), we plot only the ages of the Tioga 4 and Recess Peak moraines on Figure 3, but note that deglaciation between the two glacier positions at 13.8±1.0 ka falls within the typical range for the age of deglaciation compiled here.

A few other considerations about our data compilation warrant mention. First, there are many additional Pinedale terminal and other end moraines that have been dated in the Rocky Mountains. However, because our goal is to have moraine ages be within the context of information on deglaciation, we did not include them here. Additional Pinedale moraine chronologies from the Rocky Mountains are available from Colorado (Benson et al., 2004, 2005; Brugger, 2007), Wyoming (Phillips et al., 1997), elsewhere in the Uinta Mountains (Laabs et al., 2009 and references therein), and elsewhere around the Yellowstone Ice Cap (Licciardi and Pierce, 2008). Boulder Mountain, located in southern Utah on the Colorado Plateau, hosted a small ice cap that reached its Pinedale maximum sometime between ca. 23 and 20 ka (Marchetti et al., 2005). $^{3}He$ ages on four moraines ~3 km upvalley and near the plateau accumulation zone either overlap Pinedale terminal moraine ages (2 moraines), or date to ~16.8 and 15.2 ka (2 moraines). However, the timeline of deglaciation after ~16 ka is not known and thus not included in Figure 3 (main text). Fabel et al. (2004) provide additional bedrock ages from the Wind River Range and Sierra Nevada. Our synthesis includes predominantly cosmogenic exposure ages, but we emphasize that although cosmogenic exposure ages provide the bulk of age control on moraines in the Rocky Mountains, these studies necessarily rely on a foundation of decades of mapping and relative dating studies that have taken place across the western US.

Second, there are different approaches regarding how best to interpret a series of individual moraine boulder ages. Mainly, one can either calculate the mean age of all moraine boulder ages, or more weight can be placed on the oldest ages of the distribution. Because moraines degrade, which potentially skews ages in the young direction, and because of the general scarcity of isotopic inheritance (Putkonen and Swanson, 2003), some authors favor the oldest age in a distribution. However, since the majority of the moraines considered here are relatively young (e.g., Pinedale), and generally have age distributions that are normally distributed about their mean, we plot mean ages. Additionally, for this reason, we plot on Figure 3 (main text) the onset of deglaciation (~17.3 ka) that Schaefer et al. (2006) base on average ages, rather than the oldest age (~19.1 ka).

Finally, the onset of deglaciation proposed by Schaefer et al. (2006, ~17.3 ka) is based on a synthesis of primarily $^{10}Be$ data, along with additional radiocarbon data from northern and southern hemisphere LGM moraine datasets. Therefore the onset of deglaciation age assignment would change if $^{10}Be$ ages were recalculated using different production rates and scaling schemes. The production rate used in Schaefer et al. (2006) is ~ 2.7% percent higher than the production rate we use for western US chronologies (i.e. 5.1 vs 4.96 atoms $g^{-1}$ $yr^{-1}$). However, applying the lower production rate to the dataset of Schaefer et al. (2006) would not necessarily result in all $^{10}Be$ ages becoming 2.7% older. For example, using the St scaling scheme, recalculated $^{10}Be$ ages from the Wallowa Mountains dataset, which is included in both the Schaefer et al. (2006) and our synthesis, result in ages that are within 2% of those reported in Schaefer et al. (2006). Thus, we consider any potential change to the onset of deglaciation age reported by Schaefer et al. (2006) to be minimal and use the original age of ~17.3 ka in our discussion and figure 3 (main text).

DRI Figure captions

**Figure DR1.** Representative samples used for $^{10}Be$ dating in the upper Arkansas River valley.

**Figure DR2.** Aerial view to the northeast showing both the upper and lower flood terraces deposited at 19.2±0.1 ka and 17.8±0.6 ka. The valley wall in the top-left portion of the photo likely served as the source region for terrace flood boulders. Flow of the Arkansas River is from left to right in photo.

**Figure DR3**. Reconstructed Pinedale paleoglaciers for Lake Creek, Clear Creek, and Pine Creek valleys. Ice surface contour interval is 200-ft (~61-m).

**Figure DR4.** Hypsometry data for Lake Creek, Clear Creek, and Pine Creek paleoglaciers. Left graph shows elevation distribution by area percent; right graph by cumulative area. Data points represent 200 ft. (~61 m) bins. See supplemental text (above) for ELA reconstruction methods.

*Supplemental References*


Andres, J.T., and Miller, G.H., 1972, Quaternary history of northern Cumberland Peninsula, Baffin Island, N.W.T., Canada: Part IV: Maps of present glaciation limits and lowest equilibrium line altitude for north and south Baffin Island: Arctic and Alpine Research, v. 4, p. 45-59.

Balco, G., Stone, J.O., Lifton, N.A., and Dunai, T.J., 2008, A complete and easily accessible means of calculating surface exposure ages or erosion rates from $^{10}Be$ and $^{26}Al$ measurements: Quaternary Geochronology, v. 3, p. 174-195, doi:10.1016/j.quageo. 2007.12.001.

Balco, G., Briner, J. P., Rayburn, J., Ridge, J. C., and Schaefer, J. M., 2009, Regional beryllium-10 production rate calibration for northeastern North America: Quaternary Geochronology, v. 4, p. 93-107

Benson, L., Madole, R., Phillips, W., Landis, G., Thomas, T., and Kubik, P., 2004, The probable importance of snow and sediment shielding on cosmogenic ages of north-central Colorado Pinedale and pre-Pinedale moraines: Quaternary

Science Reviews, v. 23, p. 193–206.

Benson, L., Madole, R., Landis, G., and Gosse, J., 2005, New data for Late Pleistocene Pinedale alpine glaciation from southwestern Colorado: Quaternary Science Reviews, v. 24, p. 49–65.

Blackwelder, E., 1915, Post-Cretaceous history of the mountains of central western Wyoming: Journal of Geology, v. 23, p. 307-340.

Brugger, K.A., 2007, Cosmogenic $^{10}$Be and $^{36}$Cl ages from Late Pleistocene terminal moraine complexes in the Taylor River drainage basin, central Colorado, USA: Quaternary Science Reviews, v. 26, p. 494–499.

Brugger, K.A., and Goldstein, B.S., 1999, Paleoglacier reconstruction and late Pleistocene equilibrium-line altitudes, southern Sawatch Range, Colorado: Geological Society of America Special Paper, v. 337, p. 103-112.

Clark, D.H., and Gillespie, A.R., 1997, Timing and significance of late-glacial and Holocene cirque glaciation in the Sierra Nevada, California: Quaternary International, v. 38/39, p. 21–38.

Desilets, D., and Zreda, M., 2003, Spatial and temporal distribution of secondary cosmic-ray nucleon intensities and applications to in-situ cosmogenic dating. Earth and Planetary Science Letters, v. 206, p. 21–42.

Desilets, D., Zreda, M., and Prabu, T., 2006, Extended scaling factors for in situ cosmogenic nuclides: New measurements at low latitude: Earth and Planetary Science Letters, v. 246, p. 265–276.

Dunai, T.J., 2001, Influence of secular variation of the geomagnetic field on production rates of in situ produced cosmogenic nuclides: Earth and Planetary Science Letters, v. 193, p. 197–212.

Fabel, D., Harbor, J., Dahms, D., James, A., Elmore, D., Horn, L., Daley, K., and Steele, C., 2004, Spatial patterns of glacial erosion at a valley scale derived from terrestrial cosmogenic $^{10}$Be and $^{26}$Al concentrations in rock: Annals of the Association of American Geographers, v. 94, p. 241-255.

Gosse, J.C., Klein, J., Evenson, E.B., Lawn, B., and Middleton, R., 1995a, Beryllium-10 dating of the duration and retreat of the last Pinedale glacial sequence: Science, v. 268, p. 1329–1333.

Gosse, J.C., Evenson, E.B., Klein, J., Lawn, B., and Middleton, R., 1995b, Precise cosmogenic $^{10}$Be measurements in western North America: support for a global Younger Dryas cooling event: Geology, v. 23, p. 877–880.

Guido, Z.S., Ward, D.J., and Anderson, R.S., 2007, Pacing the post-Last Glacial Maximum demise of the Animas Valley glacier and the San Juan Mountain ice cap, Colorado: Geology, v. 35, p. 739–742.

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

Laabs, B.J.C., Refsnider, K.A., Munroe, J.S., Mickelson, D.M., Applegate, P.M., Singer, B.S., and Caffee, M.W., 2009, Latest Pleistocene glacial chronology of the Uinta Mountains: support for moisture-driven asynchrony of the last deglaciation: Quaternary Science Reviews, v. 28, p. 1171-1187.

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. 424–439.

Lanphere, M.A., Champion, D.E., Christiansen, R.L., Izett, G.A., and Obradovich, J.D., 2002, Revised ages for tuffs of the Yellowstone Plateau volcanic field: assignment of the Huckleberry Ridge Tuff to a new geomagnetic polarity event: Geological Society of America Bulletin, v. 114, p.559-568.

Leonard, E. M., 1984, Late Pleistocene equilibrium-line altitudes and modern snow accumulation patterns, San Juan Mountains, Colorado, U.S.A.: Arctic and Alpine Research, v. 16, p. 65–76.

Licciardi, J.M., Clark, P.U., Brook, E.J., Pierce, K.L., Kurz, M.D., Elmore, D., and Sharma, P., 2001, Cosmogenic $^{3}$He and $^{10}$Be chronologies of the late Pinedale northern Yellowstone ice cap, Montana, USA: Geology, v. 29, p. 1095–1098.

Licciardi, J.M., Clark, P.U., Brook, E.J., Elmore, D., and Sharma, P., 2004, Variable responses of western US glaciers during the last deglaciation: Geology, v. 32, p. 81–84.

Licciardi, J.M., and Pierce, K.L., 2008, Cosmogenic exposure-age chronologies of Pinedale and Bull Lake glaciations in greater Yellowstone and the Teton Range, USA: Quaternary Science Reviews, v. 27, p. 814-831.

Lifton, N.A., Bieber, J., Clem, J., Duldig, M., Evenson, P., Humble, J., and Pyle, R., 2005, Addressing solar modulation and long-term uncertainties in scaling secondary cosmic rays for in situ cosmogenic nuclide applications: Earth and Planetary Science Letters, v. 239, p. 140–161.

Marchetti, D.W., Cerling, T.E., and Lips, E.W., 2005, A glacial chronology for the Fish Creek drainage of Boulder Mountain, Utah, USA: Quaternary Research, v. 64, p. 263-271.

Meir, M.F., and Post, A.S., 1962, Recent variations in mass net budgets of glaciers in western North America. IUGG/IASH committee on snow and ice, Symposium of Obergurgl: International Association of Scientific Hydrology Publication, v. 58, p. 63-77.

Nishiizumi, K., Imamura, M., Caffee, M., Southon, J., Finkel, R., and McAnich, J., 2007, Absolute calibration of $^{10}$Be AMS standards: Nuclear Instruments and Methods in Physics Research B, v. 258, p. 403-413.

Pierce, K.l., 1979, History and dynamics of glaciation in the northern Yellowstone National Park area: US Geological Survey Professional Paper, 729-F, 90 pp.

Phillips, F.M., Zreda, M.G., Benson, L.V., Plummer, M.A., Elmore, D., and Sharma, P., 1996, Chronology for fluctuations in late Pleistocene Sierra Nevada glaciers and lakes. Science, v. 274, p. 749–751.

Phillips, F.M., Zreda, M.G., Evenson, E.B., Hall, R.D., Chadwick, O.A., and Sharma, P., 1997, Cosmogenic Cl-36 and Be-10 ages of Quaternary glacial and fluvial deposits of the Wind River Range, Wyoming: Geological Society of America Bulletin, v. 109, p. 1453–1463.

Phillips, F.M., Zreda, M.G., Plummer, M.A., Elmore, D., and Clark, D.H., 2009, Glacial geology and chronology of Bishop Creek and vicinity, eastern Sierra Nevada, California: Geological Society of America Bulletin, v. 121, p. 1013-1033.

Porter, S. C., 1975, Equilibrium-line altitudes of late Quaternary glaciers in the Southern Alps, New Zealand: Quaternary Research, v. 5, p. 27–47.

Porter, S.C., and Swanson, T.W., 2008, $^{36}$Cl Dating of the classic Pleistocene glacial record in the northeastern Cascade Range, Washington: American Journal of Science, v. 308, p. 130-166.

Putkonen, J., and Swanson, T., 2003, Accuracy of cosmogenic ages for moraines: Quaternary Research, v. 59, p. 255–261.

Putnam. A.E., Schaefer, J.M., Barrell, D.J.A., Vandergoes, M., Denton, G.H., Kaplan, M.R., Finkel, R.C., Schwartz, R., Goehring, B.M., and Kelley, S.E., 2010, In situ cosmogenic $^{10}$Be production-rate calibration from the Southern Alps, New Zealand: Quaternary Science Reviews, v. 5, p. 392-409 doi:10.1016/j.quageo.2009.12.001.

Refsnider, K.A., Laabs, B.J.C., Plummer, M.A., Mickelson, D.M., Singer, B.S., and Caffee, M.W., 2008, Last Glacial Maximum climate inferences from cosmogenic dating and glacier modeling of the western Uinta ice field, Uinta Mountains, Utah. Quaternary Research, v. 69, p. 130–144.

Sarna-Wojcicki, A.M., Pringle, M.S.,Wijbrans, J., 2000, New 40Ar/39Ar age of the Bishop Tuff from multiple sites and sedimentation rate calibration of the Matuyama-Brunhes boundary: Journal of Geophysical Research, v. 105, p. 21 431-21 443.

Schaefer, J.M., Denton, G.H., Ivy-Ochs, S., Kubik, P.W., Barrell, D.J., Phillips, F., Schluechter, C., Andersen, B.G., and Lowell, T.V., 2006, Near- Synchronous Interhemispheric Termination of the Last Glacial Maximum in Mid-Latitudes: Science, v. 312, p. 1510-1513.

Scott, G. R, 1975, Reconnaissance geologic map of the Buena Vista quadrangle, Chaffee and Park Counties, Colorado: U.S. Geological Survey Map MF-657, 1:62,500 scale.

Scott, G. R, 1984, Part III-Pleistocene floods along the Arkansas River, Chaffee County, Colorado. *In* Nelson, A. R., Shroba, R.R, and Scott, G. R, *Quaternary Deposits of the Upper Arkansas River Valley, Colorado.* Boulder, Colorado: American Quaternary Association, 8th Biennial Meeting, August 16-17, 1984, unpublished guide for Field Trip No.7, 51-57.

Scott, G.R, Taylor, R.B., Epis, R.C., and Wobus, R.A., 1978, Geologic map of the Pueblo l° x 2° Quadrangle, south-central Colorado: U.S. Geological Survey Map MI-1022, 1:250,000 scale.

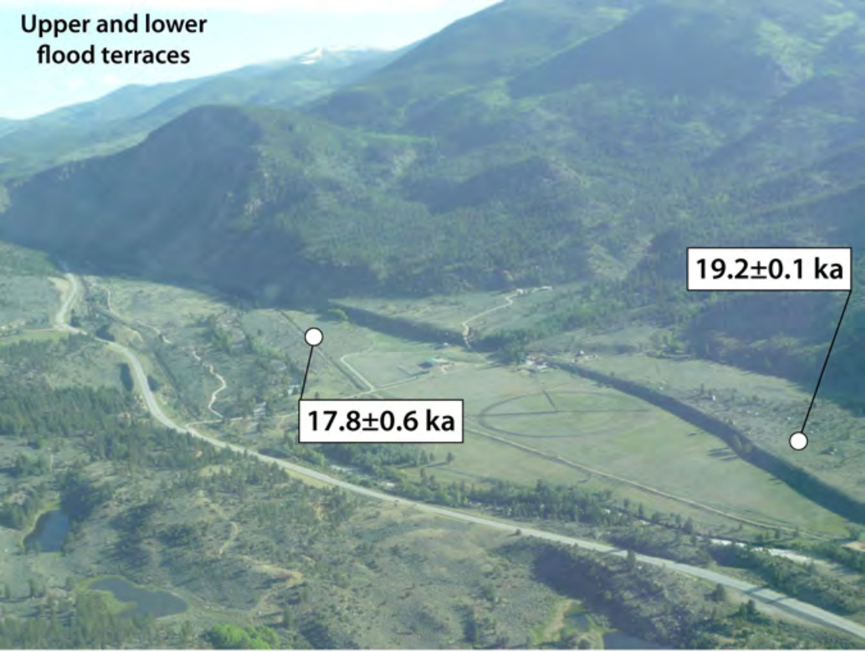
Stone, J.O., 2000, Air pressure and cosmogenic isotope production: Journal of Geophysical Research, v. 105, p. 23,753–23,759.

Tweto, O., Steven, T.A., Hail, W.J., and Moench, R.H., 1976, Preliminary geologic map of the Montrose l° x 2° Quadrangle, southwestern Colorado: U.S. Geological Survey Map MF-761, 1:250,000 scale.

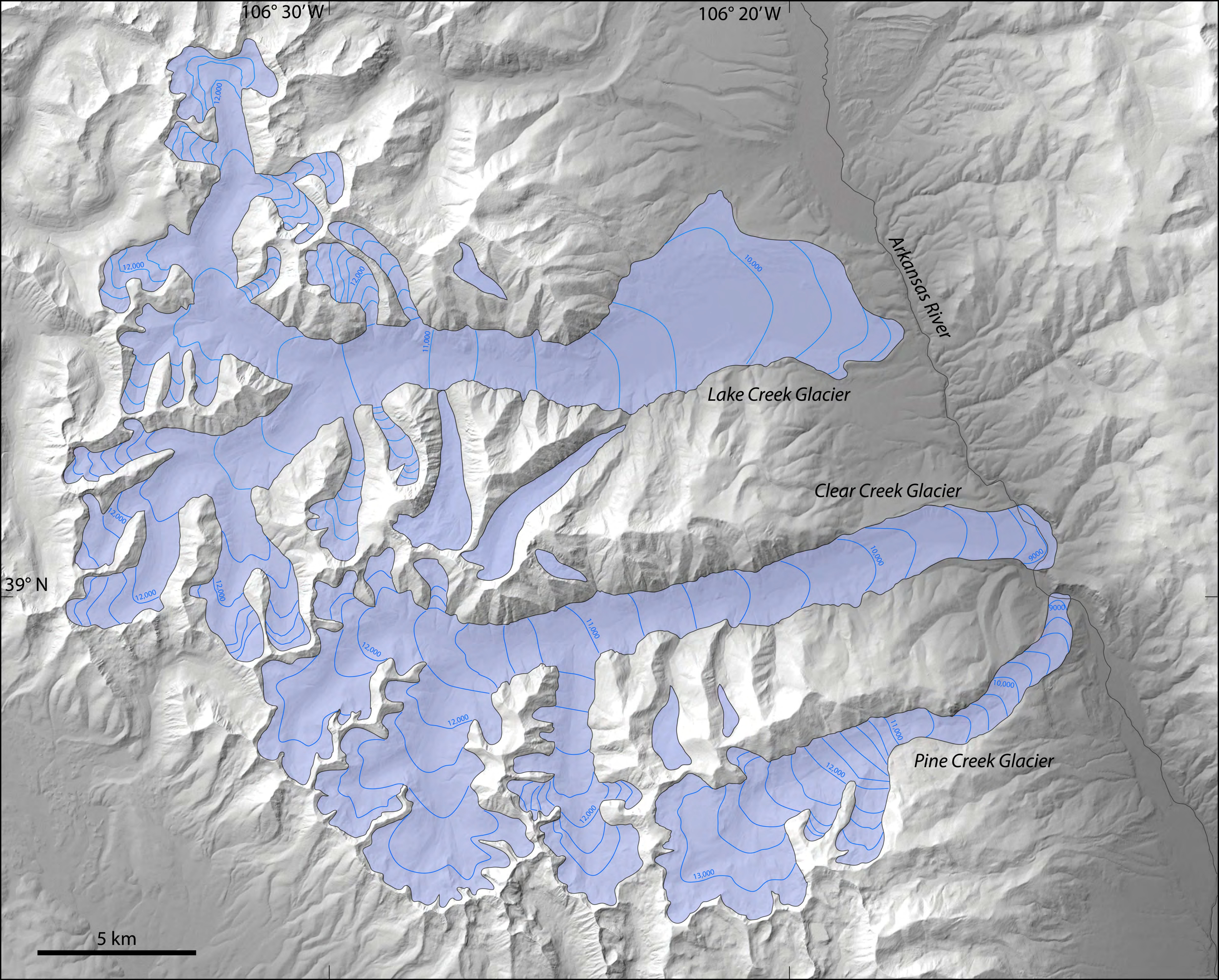
Tweto, O., Moench, R H., and Reed, C., Jr., 1978, Geologic map of the Leadville l° x 2° quadrangle, northeastern Colorado: U.S. Geological Survey Map 1-999, 1:250,000 scale.

Ward, D.J., Anderson, R.S., Guido, Z.S., and Briner, J.P., 2009, Numerical modeling of cosmogenic deglaciation records, Front Range and San Juan mountains, Colorado: Journal of Geophysical Research, v. 114, F01026.

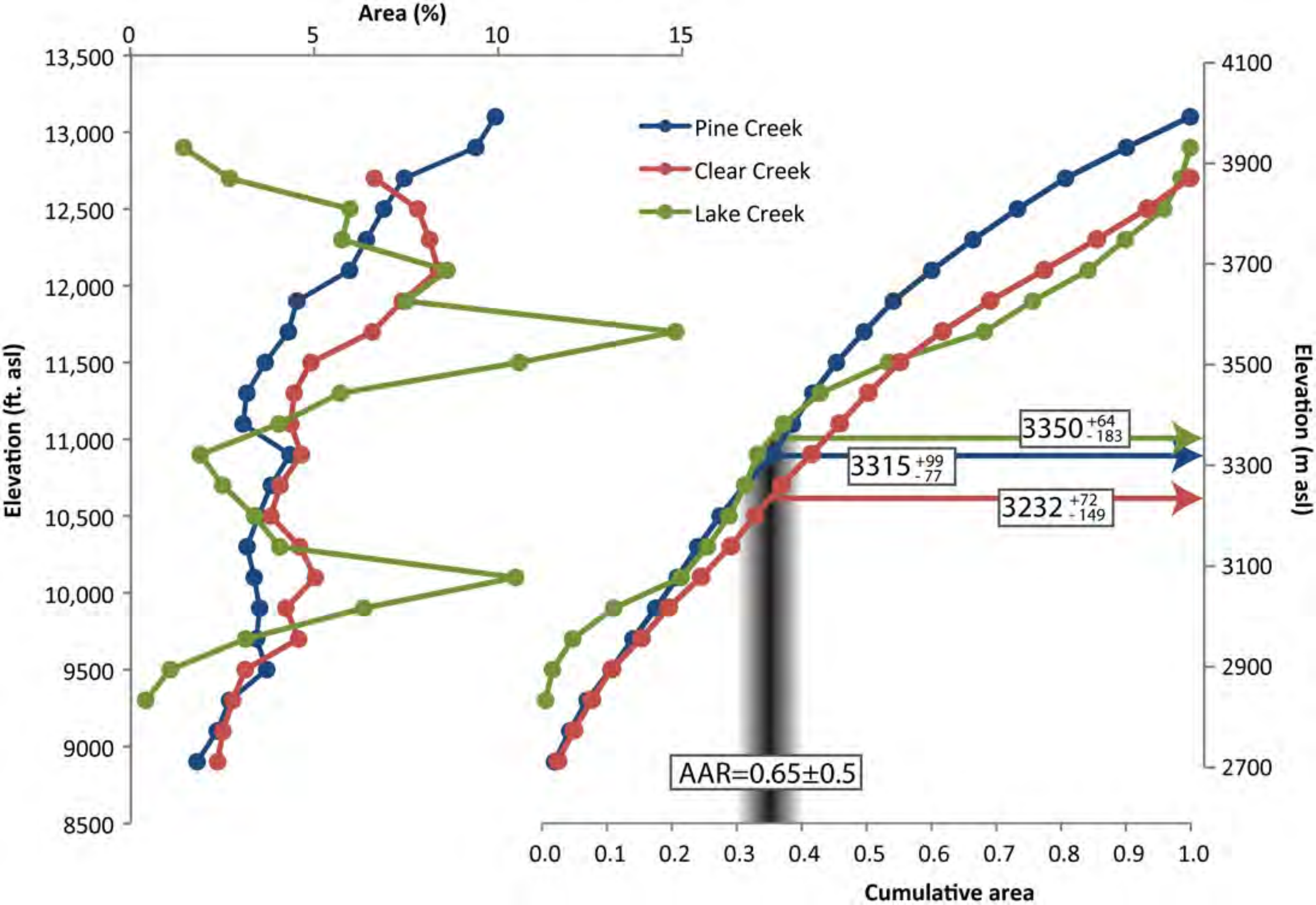

Young et al. DRI Figure 1




Young et al. DRI Figure 2



106° 30′ W
106° 20′ W
39° N
Arkansas River
Lake Creek Glacier
Clear Creek Glacier
Pine Creek Glacier
12,000
11,000
10,000
9000
13,000
5 km



Area (%)
0
5
10
15
13,500
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9500
9000
8500
Elevation (ft. asl)
Pine Creek
Clear Creek
Lake Creek
4100
3900
3700
3500
3300
3100
2900
2700
Elevation (m asl)
$3350^{+64}_{-183}$
$3315^{+99}_{-77}$
$3232^{+72}_{-149}$
AAR=0.65±0.5
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Cumulative area

*Table DR1. Sample information for western US cosmogenic surface exposure ages*

| Sample | Latitude | Longitiude | Elevation | Thickness | Density | Shielding correction | $^{10}$Be concentration (atoms g$^{-1}$) | $^{10}$Be uncertainty (atoms g$^{-1}$) | $^{10}$Be standard | $^{10}$Be age[a] | Sample type | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Lake Creek, CO*** | | | | | | | | | | | | |
| AR09-01 | 39.065896 | -106.407026 | 2930 | 1.5 | 2.65 | 0.996 | 513651.9202 | 12461.80 | 07KNSTD | 14.7 ± 0.4 | bedrock | 1 |
| AR09-10 | 39.070594 | -106.471824 | 3048 | 3.5 | 2.65 | 0.989 | 508739.7905 | 13867.28 | 07KNSTD | 13.9 ± 0.4 | bedrock | 1 |
| AR09-11 | 39.100977 | -106.544485 | 3261 | 4 | 2.65 | 0.983 | 543494.3132 | 10770.61 | 07KNSTD | 13.2 ± 0.3 | bedrock | 1 |
| DC-91-2 | 39.069676 | -106.288887 | 2850 | 1 | 2.7 | 1 | 730000 | 20000 | KNSTD | 19.7 ± 0.5 | moraine boulder | 2 |
| ***Clear Creek, CO*** | | | | | | | | | | | | |
| MF06-01 | 39.027 | -106.269 | 2938 | 2 | 2.65 | 1 | 682066.2649 | 20016.76 | 07KNSTD | 19.5 ± 0.6 | moraine boulder | 1 |
| MF06-02 | 39.028 | -106.274 | 2953 | 1.5 | 2.65 | 1 | 686464.4184 | 15997.73 | 07KNSTD | 19.3 ± 0.4 | moraine boulder | 1 |
| MF06-03 | 39.027 | -106.281 | 2957 | 2 | 2.65 | 1 | 768307.6912 | 19615.79 | 07KNSTD | 21.7 ± 0.6 | moraine boulder | 1 |
| MF06-04 | 39.026 | -106.285 | 2964 | 2.5 | 2.65 | 1 | 676327.9371 | 12545.56 | 07KNSTD | 19.1 ± 0.4 | moraine boulder | 1 |
| MF06-05 | 39.026 | -106.286 | 2971 | 3 | 2.65 | 1 | 540315.0162 | 14668.53 | 07KNSTD | 15.2 ± 0.4 | moraine boulder | 1 |
| AR09-03 | 39.002602 | -106.33924 | 2835 | 2 | 2.65 | 0.992 | 462709.1138 | 9308.48 | 07KNSTD | 14.1 ± 0.3 | bedrock | 1 |
| ***Pine Creek, CO*** | | | | | | | | | | | | |
| PC1 | 38.9808 | -106.23245 | 2992 | 3 | 2.65 | 1 | 828000 | 19360 | KNSTD | 20.9 ± 0.5 | moraine boulder | 3 |
| PC2 | 38.9807 | -106.232369 | 2992 | 1 | 2.65 | 1 | 546000 | 15894 | KNSTD | 13.5 ± 0.4 | moraine boulder | 3 |
| PC3 | 38.9802 | -106.23405 | 2911 | 1 | 2.65 | 1 | 599000 | 15943 | KNSTD | 15.6 ± 0.4 | moraine boulder | 3 |
| PC4 | 38.9802 | -106.23405 | 2911 | 1 | 2.65 | 1 | 859000 | 20037 | KNSTD | 22.4 ± 0.5 | moraine boulder | 3 |
| PC5 | 38.9818 | -106.23165 | 2845 | 3 | 2.65 | 1 | 890000 | 26017 | KNSTD | 24.5 ± 0.7 | moraine boulder | 3 |
| PC6 | 38.9817 | -106.231633 | 2893 | 1 | 2.65 | 1 | 610000 | 14423 | KNSTD | 16.0 ± 0.4 | moraine boulder | 3 |
| PC7 | 38.9865 | -106.2274 | 2877 | 1 | 2.65 | 1 | 858000 | 20223 | KNSTD | 22.8 ± 0.5 | moraine boulder | 3 |
| PC8 | 38.9889 | -106.22725 | 2851 | 1 | 2.65 | 1 | 789000 | 15449 | KNSTD | 21.3 ± 0.4 | moraine boulder | 3 |
| PC9 | 38.9901 | -106.22695 | 2837 | 1 | 2.65 | 1 | 566000 | 13421 | KNSTD | 15.4 ± 0.4 | moraine boulder | 3 |
| PC11 | 38.9917 | -106.227233 | 2835 | 1 | 2.65 | 1 | 564000 | 13339 | KNSTD | 15.3 ± 0.4 | moraine boulder | 3 |
| PC12 | 38.9980 | -106.228633 | 2739 | 1.5 | 2.65 | 1 | 560500 | 13500 | KNSTD | 16.2 ± 0.4 | moraine boulder | 3 |
| PC13 | 38.9979 | -106.228528 | 2739 | 1 | 2.65 | 1 | 558000 | 13426 | KNSTD | 16.1 ± 0.4 | moraine boulder | 3 |
| AR09-07 | 38.974371 | -106.250598 | 2931 | 3 | 2.65 | 0.996 | 536779.4137 | 14280.09 | 07KNSTD | 15.6 ± 0.4 | bedrock | 1 |
| AR09-08 | 38.974371 | -106.250598 | 2931 | 1 | 2.65 | 0.996 | 537780.799 | 10675.82 | 07KNSTD | 15.3 ± 0.3 | bedrock | 1 |
| ***ARK River valley, CO, Lower flood terrace*** | | | | | | | | | | | | |
| QPOY-01 | 38.983 | -106.212 | 2616 | 2 | 2.65 | 0.995 | 495688.5285 | 12709.90 | 07KNSTD | 17.3 ± 0.4 | flood boulder | 1 |
| QPOY-02 | 38.984 | -106.212 | 2616 | 4 | 2.65 | 0.999 | 486011.3045 | 23460.67 | 07KNSTD | 17.2 ± 0.8 | flood boulder | 1 |
| AR09-05 | 38.942935 | -106.189466 | 2555 | 3 | 2.65 | 0.999 | 503687.0176 | 9990.57 | 07KNSTD | 18.4 ± 0.4 | flood boulder | 1 |
| AR09-06 | 38.942935 | -106.189466 | 2555 | 2 | 2.65 | 0.999 | 499121.383 | 12060.47 | 07KNSTD | 18.1 ± 0.4 | flood boulder | 1 |
| ***ARK River valley, CO, Upper flood terrace*** | | | | | | | | | | | | |
| QPOO-2 | 38.972 | -106.204 | 2620 | 2.5 | 2.65 | 0.996 | 545831.9166 | 23470.77 | 07KNSTD | 19.1 ± 0.8 | flood boulder | 1 |
| QPOO-4 | 38.975 | -106.205 | 2620 | 2 | 2.65 | 0.998 | 600223.1971 | 27610.27 | 07KNSTD | 20.9 ± 1.0 | flood boulder | 1 |
| QPOO-01 | 38.975 | -106.205 | 2620 | 2 | 2.65 | 0.996 | 549660.9314 | 18527.31 | 07KNSTD | 19.1 ± 0.6 | flood boulder | 1 |
| QPOO-03 | 38.965 | -106.201 | 2620 | 2 | 2.65 | 0.999 | 556144.5244 | 13713.09 | 07KNSTD | 19.3 ± 0.5 | flood boulder | 1 |
| ***Animas Valley, CO*** | | | | | | | | | | | | |
| Baker's Bridge | 37.46771 | -107.79045 | 2155 | 0.7 | 2.7 | 0.894 | 359300 | 9000 | KNSTD | 17.5 ± 0.4 | bedrock | 4 |
| Tacoma | 37.56023 | -107.77917 | 2285 | 2.5 | 2.7 | 0.917 | 330100 | 11600 | KNSTD | 14.6 ± 0.5 | bedrock | 4 |
| Needleton | 37.6286 | -107.69437 | 2540 | 0.6 | 2.7 | 0.918 | 415300 | 10400 | KNSTD | 15.3 ± 0.4 | bedrock | 4 |
| Silverton | 37.78546 | -107.66853 | 2835 | 3.5 | 2.7 | 0.482 | 242900 | 6400 | KNSTD | 14.3 ± 0.4 | bedrock | 4 |
| Highland Mary Lake | 37.91239 | -107.5807 | 3704 | 1.2 | 2.7 | 0.948 | 698384 | 25421 | KNSTD | 12.6 ± 0.5 | bedrock | 4 |
| Elk Creek | 37.71465 | -107.54033 | 3871 | 2.3 | 2.7 | 0.947 | 925981 | 25464 | KNSTD | 15.6 ± 0.4 | bedrock | 4 |
| terminal outwash profile[b] | 37.09641 | -107.88684 | 1872 | NA | NA | NA | NA | NA | NA | 19.4 ± 1.5 | depth profile | 4 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Middle Boulder Creek, CO*** | | | | | | | | | | | | |
| *Terminal moraine* | | | | | | | | | | | | |
| 99-t74[c] | 40 | -105.558 | 2982 | 5 | 2.7 | 1 | 4322600 ($^{26}$Al) | 206600 ($^{26}$Al) | KNSTD | 17.8 ± 0.9[c] | moraine boulder | 2 |
| 99-t76 | 40 | -105.558 | 2982 | 5 | 2.7 | 1 | 822400 | 20300 | KNSTD | 20.6 ± 0.5 | moraine boulder | 2 |
| 99-t76[c] | 40 | -105.558 | 2982 | 5 | 2.7 | 1 | 4966400 ($^{26}$Al) | 234700 ($^{26}$Al) | KNSTD | 20.5 ± 1.0[c] | moraine boulder | 2 |
| MB4J-0 | 39.9579 | -105.5242 | 2590 | 5 | 2.7 | 1 | 570029 | 51815 | KNSTD | 18.2 ± 1.7 | moraine boulder | 5 |
| *Upvalley bedrock* | | | | | | | | | | | | |
| 33-JB-25 | 39.9978 | -105.6352 | 3162 | 3 | 2.7 | 0.978 | 552800 | 18100 | KNSTD | 12.5 ± 0.4 | bedrock | 5 |
| GP4J-1 | 40.012 | -105.6749 | 3549 | 3 | 2.7 | 0.991 | 752900 | 23700 | KNSTD | 13.5 ± 0.4 | bedrock | 5 |
| GP4J-2 | 40.0111 | -105.6741 | 3521 | 3 | 2.7 | 0.979 | 747700 | 23100 | KNSTD | 13.8 ± 0.4 | bedrock | 5 |
| GP4J-3 | 40.0097 | -105.6752 | 3520 | 10 | 2.7 | 0.995 | 704500 | 25600 | KNSTD | 13.6 ± 0.5 | bedrock | 5 |
| GP4J-4 | 40.0088 | -105.6742 | 3484 | 3 | 2.7 | 0.993 | 722600 | 23000 | KNSTD | 13.4 ± 0.4 | bedrock | 5 |
| GP4J-5 | 40.0077 | -105.6741 | 3463 | 2 | 2.7 | 0.988 | 705200 | 22700 | KNSTD | 13.2 ± 0.4 | bedrock | 5 |
| GP4J-6 | 40.0103 | -105.6681 | 3451 | 1 | 2.7 | 0.981 | 704400 | 27500 | KNSTD | 13.3 ± 0.5 | bedrock | 5 |
| GP4J-7 | 40.0065 | -105.6656 | 3434 | 1 | 2.7 | 0.986 | 635200 | 20100 | KNSTD | 12.0 ± 0.4 | bedrock | 5 |
| GP4J-10 | 39.9713 | -105.6043 | 2904 | 5 | 2.7 | 0.976 | 514200 | 14400 | KNSTD | 13.8 ± 0.4 | bedrock | 5 |
| GP4J-11 | 39.9872 | -105.6242 | 3051 | 5 | 2.7 | 0.972 | 528200 | 19100 | KNSTD | 13.1 ± 0.5 | bedrock | 5 |
| GP4J-23 | 39.9517 | -105.5836 | 2708 | 5 | 2.7 | 0.979 | 587890 | 20575 | KNSTD | 17.8 ± 0.6 | bedrock | 5 |
| ***Jenny Lake, WY*** | | | | | | | | | | | | |
| *Outer Jenny Lake moraine* | | | | | | | | | | | | |
| OJEN-1 | 43.7659 | -110.7104 | 2102 | 2.25 | 2.7 | 1 | 354000 | 6000 | KNSTD | 14.1 ± 0.3 | moraine boulder | 7 |
| OJEN-2 | 43.7664 | -110.7107 | 2094 | 2.5 | 2.7 | 1 | 374000 | 9000 | KNSTD | 15.0 ± 0.4 | moraine boulder | 7 |
| OJEN-3 | 43.7664 | -110.711 | 2094 | 1.5 | 2.7 | 1 | 337000 | 8000 | KNSTD | 13.4 ± 0.3 | moraine boulder | 7 |
| OJEN-5 | 43.7656 | -110.7107 | 2092 | 1.5 | 2.7 | 1 | 361000 | 8000 | KNSTD | 14.4 ± 0.3 | moraine boulder | 7 |
| OJEN-6 | 43.7652 | -110.7104 | 2102 | 1.5 | 2.7 | 1 | 389000 | 9000 | KNSTD | 15.4 ± 0.4 | moraine boulder | 7 |
| OJEN-7 | 43.765 | -110.7103 | 2099 | 2 | 2.7 | 1 | 380000 | 9000 | KNSTD | 15.1 ± 0.4 | moraine boulder | 7 |
| OJEN-8 | 43.7646 | -110.7105 | 2095 | 1.5 | 2.7 | 1 | 364000 | 9000 | KNSTD | 14.4 ± 0.4 | moraine boulder | 7 |
| OJEN-9 | 43.7646 | -110.7105 | 2095 | 2 | 2.7 | 1 | 383000 | 9000 | KNSTD | 15.3 ± 0.4 | moraine boulder | 7 |
| OJEN-10 | 43.7831 | -110.7303 | 2115 | 2 | 2.7 | 0.992 | 340000 | 8000 | KNSTD | 13.5 ± 0.3 | moraine boulder | 7 |
| OJEN-11 | 43.784 | -110.7289 | 2100 | 2 | 2.7 | 0.992 | 375000 | 14000 | KNSTD | 15.0 ± 0.6 | moraine boulder | 7 |
| *Inner Jenny Lake moraine* | | | | | | | | | | | | |
| IJEN-1 | 43.7807 | -110.7256 | 2113 | 1.75 | 2.7 | 1 | 337000 | 8000 | KNSTD | 13.2 ± 0.3 | moraine boulder | 7 |
| IJEN-2 | 43.7804 | -110.7248 | 2097 | 1.75 | 2.7 | 1 | 318000 | 9000 | KNSTD | 12.6 ± 0.4 | moraine boulder | 7 |
| IJEN-3 | 43.7799 | -110.7231 | 2108 | 2 | 2.7 | 1 | 355000 | 8000 | KNSTD | 14.0 ± 0.3 | moraine boulder | 7 |
| IJEN-5 | 43.7779 | -110.7219 | 2110 | 2 | 2.7 | 1 | 296000 | 7000 | KNSTD | 11.7 ± 0.3 | moraine boulder | 7 |
| IJEN-6 | 43.7751 | -110.7186 | 2103 | 1.75 | 2.7 | 1 | 359000 | 9000 | KNSTD | 14.2 ± 0.2 | moraine boulder | 7 |
| IJEN-7 | 43.7669 | -110.714 | 2093 | 2 | 2.7 | 1 | 324000 | 8000 | KNSTD | 12.9 ± 0.3 | moraine boulder | 7 |
| IJEN-11 | 43.7581 | -110.7158 | 2084 | 2 | 2.7 | 1 | 374000 | 9000 | KNSTD | 15.0 ± 0.4 | moraine boulder | 7 |
| IJEN-13 | 43.7577 | -110.7165 | 2090 | 1.5 | 2.7 | 1 | 356000 | 8000 | KNSTD | 14.2 ± 0.3 | moraine boulder | 7 |
| *Upvalley* | | | | | | | | | | | | |
| BED-1 | 43.785 | -110.8303 | 2618 | 1 | 2.7 | 0.955 | 473000 | 11000 | KNSTD | 13.8 ± 0.3 | bedrock | 7 |
| BED-2 | 43.767 | -110.7491 | 2214 | 2.5 | 2.7 | 0.973 | 390000 | 7000 | KNSTD | 14.8 ± 0.3 | bedrock | 7 |
| LS-1 | 43.7921 | -110.8414 | 2767 | 1 | 2.7 | 0.983 | 483000 | 9000 | KNSTD | 12.5 ± 0.3 | boulder | 7 |
| LS-7 | 43.7911 | -110.8418 | 2787 | 1.5 | 2.7 | 0.982 | 528000 | 16000 | KNSTD | 13.5 ± 0.3 | boulder | 7 |
| LS-8 | 43.7914 | -110.8416 | 2764 | 2.25 | 2.7 | 0.982 | 472000 | 11000 | KNSTD | 12.3 ± 0.3 | boulder | 7 |
| ***NW Yellowstone, MT, WY*** | | | | | | | | | | | | |
| *Eightmile terminal moraine* | | | | | | | | | | | | |
| 8-B2 | 45.429 | -110.707 | 1550 | 2.5 | 2.7 | 1 | 259000 | 17000 | NIST_Certified* | 14.8 ± 1.0 | moraine boulder | 7,8 |
| 8-D1 | 45.429 | -110.705 | 1545 | 0.75 | 2.7 | 1 | 283000 | 16000 | NIST_Certified* | 16.0 ± 0.9 | moraine boulder | 7,8 |
| 8-F2 | 45.437 | -110.695 | 1544 | 1.5 | 2.7 | 1 | 308000 | 28000 | NIST_Certified* | 17.6 ± 1.6 | moraine boulder | 7,8 |
| 8-G2 | 45.436 | -110.691 | 1529 | 1 | 2.7 | 1 | 334000 | 28000 | NIST_Certified* | 19.2 ± 1.6 | moraine boulder | 7,8 |
| 8-I1_I2 | 45.435 | -110.69 | 1529 | 1.75 | 2.7 | 1 | 286000 | 12000 | NIST_Certified* | 16.5 ± 0.7 | moraine boulder | 7,8 |
| 8-J1_J2 | 45.365 | -110.69 | 1554 | 2 | 2.7 | 1 | 298000 | 25000 | NIST_Certified* | 17.0 ± 1.4 | moraine boulder | 7,8 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-K1 | 45.429 | -110.688 | 1536 | 2.75 | 2.7 | 1 | 291000 | 10000 | NIST_Certified* | 16.9 ± 0.6 | moraine boulder | 7,8 |
| 8-L1_L2 | 45.365 | -110.69 | 1554 | 3 | 2.7 | 1 | 271000 | 12000 | NIST_Certified* | 15.6 ± 0.7 | moraine boulder | 7,8 |
| 8-M2 | 45.363 | -110.691 | 1561 | 2.5 | 2.7 | 1 | 280000 | 11000 | NIST_Certified* | 15.9 ± 0.6 | moraine boulder | 7,8 |
| | | | | | | | | | KNSTD | | | |
| *Chico moraines* | | | | | | | | | KNSTD | | | |
| CH-1A | 45.339 | -110.698 | 1628 | 2.5 | 2.7 | 1 | 264000 | 22000 | NIST_Certified* | 14.3 ± 1.2 | moraine boulder | 7,8 |
| CH-2A | 45.337 | -110.697 | 1634 | 1.75 | 2.7 | 1 | 290000 | 18000 | NIST_Certified* | 15.5 ± 1.0 | moraine boulder | 7,8 |
| CH-3B | 45.334 | -110.695 | 1652 | 1.75 | 2.7 | 1 | 298000 | 26000 | NIST_Certified* | 15.8 ± 1.4 | moraine boulder | 7,8 |
| CH-6A | 45.335 | -110.705 | 1615 | 1.75 | 2.7 | 1 | 264000 | 22000 | NIST_Certified* | 14.3 ± 1.2 | moraine boulder | 7,8 |
| CH-6B | 45.335 | -110.705 | 1615 | 1.75 | 2.7 | 1 | 248000 | 27000 | NIST_Certified* | 13.5 ± 1.5 | moraine boulder | 7,8 |
| CH-8A | 45.336 | -110.704 | 1615 | 0.75 | 2.7 | 1 | 327000 | 19000 | NIST_Certified* | 17.6 ± 1.0 | moraine boulder | 7,8 |
| CH-9B | 45.338 | -110.703 | 1618 | 1.75 | 2.7 | 1 | 310000 | 21000 | NIST_Certified* | 16.8 ± 1.2 | moraine boulder | 7,8 |
| CH-10B | 45.34 | -110.703 | 1612 | 1.25 | 2.7 | 1 | 347000 | 20000 | NIST_Certified* | 18.8 ± 1.1 | moraine boulder | 7,8 |
| CH-11B | 45.342 | -110.703 | 1615 | 0.75 | 2.7 | 1 | 297000 | 14000 | NIST_Certified* | 16.0 ± 0.8 | moraine boulder | 7,8 |
| | | | | | | | | | KNSTD | | | |
| Deckards Flats moraine | | | | | | | | | KNSTD | | | |
| DF-1A | 45.039 | -110.685 | 1811 | 0.75 | 2.7 | 1 | 299000 | 13000 | NIST_Certified* | 14.0 ± 0.6 | moraine boulder | 7,8 |
| DF-2B | 45.039 | -110.685 | 1811 | 1.75 | 2.7 | 1 | 271000 | 25000 | NIST_Certified* | 12.8 ± 1.2 | moraine boulder | 7,8 |
| DF-3B | 45.039 | -110.685 | 1811 | 1.75 | 2.7 | 1 | 283000 | 19000 | NIST_Certified* | 13.4 ± 0.9 | moraine boulder | 7,8 |
| DF-4A | 45.039 | -110.685 | 1811 | 1.75 | 2.7 | 1 | 267000 | 23000 | NIST_Certified* | 12.6 ± 1.1 | moraine boulder | 7,8 |
| DF-5B | 45.039 | -110.685 | 1811 | 1.5 | 2.7 | 1 | 345000 | 14000 | NIST_Certified* | 16.3 ± 0.7 | moraine boulder | 7,8 |
| DF-6A | 45.039 | -110.685 | 1811 | 1.75 | 2.7 | 1 | 288000 | 15000 | NIST_Certified* | 13.7 ± 0.7 | moraine boulder | 7,8 |
| DF-6B | 45.039 | -110.685 | 1811 | 1.75 | 2.7 | 1 | 319000 | 24000 | NIST_Certified* | 15.1 ± 1.1 | moraine boulder | 7,8 |
| DF-7A | 45.039 | -110.685 | 1811 | 1.5 | 2.7 | 1 | 307000 | 16000 | NIST_Certified* | 14.5 ± 0.8 | moraine boulder | 7,8 |
| DF-8A | 45.038 | -110.685 | 1807 | 1.25 | 2.7 | 1 | 323000 | 19000 | NIST_Certified* | 15.3 ± 0.9 | moraine boulder | 7,8 |
| DF-9B | 45.038 | -110.684 | 1804 | 1.75 | 2.7 | 1 | 281000 | 11000 | NIST_Certified* | 13.4 ± 0.5 | moraine boulder | 7,8 |
| DF-10A | 45.038 | -110.683 | 1801 | 0.75 | 2.7 | 1 | 322000 | 39000 | NIST_Certified* | 15.2 ± 1.9 | moraine boulder | 7,8 |
| *Junction Butte moraine* | | | | | | | | | | | | |
| JB-1 | 44.9087 | -110.3742 | 1942 | 0.75 | 2.7 | 1 | 342000 | 8000 | KNSTD | 14.7 ± 0.3 | moraine boulder | 7 |
| JB-2 | 44.9088 | -110.3747 | 1941 | 1 | 2.7 | 1 | 333000 | 8000 | KNSTD | 14.3 ± 0.3 | moraine boulder | 7 |
| JB-4 | 44.9145 | -110.3774 | 1907 | 1 | 2.7 | 1 | 321000 | 6000 | KNSTD | 14.1 ± 0.3 | moraine boulder | 7 |
| JB-7 | 44.9169 | -110.3776 | 1897 | 1 | 2.7 | 1 | 320000 | 7000 | KNSTD | 14.2 ± 0.3 | moraine boulder | 7 |
| JB-8 | 44.9174 | -110.3783 | 1885 | 1 | 2.7 | 1 | 290000 | 8000 | KNSTD | 13.0 ± 0.4 | moraine boulder | 7 |
| JB-11 | 44.9206 | -110.3755 | 1886 | 1 | 2.7 | 1 | 322000 | 8000 | KNSTD | 14.4 ± 0.4 | moraine boulder | 7 |
| ***Wallowa, OR*** | | | | | | | | | | | | |
| *TTO terminal moraine* | | | | | | | | | | | | |
| TTO-2B | 45.321 | -117.196 | 1530 | 1.75 | 2.8 | 1 | 363000 | 16000 | NIST_Certified* | 21.0 ± 0.9 | moraine boulder | 9 |
| TTO-3B | 45.319 | -117.195 | 1536 | 1.75 | 2.8 | 1 | 377000 | 12000 | NIST_Certified* | 21.7 ± 0.7 | moraine boulder | 9 |
| TTO-7A | 45.326 | -117.199 | 1524 | 2 | 2.8 | 1 | 373000 | 27000 | NIST_Certified* | 21.7 ± 1.6 | moraine boulder | 9 |
| TTO-9B | 45.328 | -117.2 | 1509 | 1 | 2.8 | 1 | 355000 | 20000 | NIST_Certified* | 20.7 ± 1.2 | moraine boulder | 9 |
| TTO-10B | 45.326 | -117.199 | 1524 | 1.25 | 2.8 | 1 | 399000 | 24000 | NIST_Certified* | 23.1 ± 1.4 | moraine boulder | 9 |
| TTO-11A | 45.333 | -117.205 | 1481 | 1.5 | 2.8 | 1 | 373000 | 21000 | NIST_Certified* | 22.3 ± 1.3 | moraine boulder | 9 |
| *TTY end moraine* | | | | | | | | | | | | |
| TTY-1B | 45.312 | -117.193 | 1558 | 1.75 | 2.8 | 1 | 296000 | 18000 | NIST_Certified* | 16.7 ± 1.0 | moraine boulder | 9 |
| TTY-3B | 45.317 | -117.195 | 1542 | 1.75 | 2.8 | 1 | 298000 | 24000 | NIST_Certified* | 17.0 ± 1.4 | moraine boulder | 9 |
| TTY-6A | 45.325 | -117.199 | 1524 | 2 | 2.8 | 1 | 285000 | 21000 | NIST_Certified* | 16.6 ± 1.2 | moraine boulder | 9 |
| TTY-8A | 45.329 | -117.202 | 1498 | 2 | 2.8 | 1 | 366000 | 27000 | NIST_Certified* | 21.7 ± 1.6 | moraine boulder | 9 |
| TTY-10B | 45.331 | -117.203 | 1487 | 1.5 | 2.8 | 1 | 351000 | 23000 | NIST_Certified* | 20.9 ± 1.4 | moraine boulder | 9 |
| TTY-12B | 45.317 | -117.221 | 1509 | 1.5 | 2.8 | 1 | 351000 | 19000 | NIST_Certified* | 20.6 ± 1.1 | moraine boulder | 9 |
| TTY-13B | 45.335 | -117.208 | 1439 | 1.75 | 2.8 | 1 | 274000 | 12000 | NIST_Certified* | 16.9 ± 0.7 | moraine boulder | 9 |
| *WTO end moraine* | | | | | | | | | | | | |
| WTO-1B | 45.324 | -117.222 | 1475 | 1.75 | 2.8 | 1 | 294000 | 14000 | NIST_Certified* | 17.7 ± 0.8 | moraine boulder | 9 |
| WTO-1C | 45.324 | -117.222 | 1475 | 1.75 | 2.8 | 1 | 313000 | 14000 | NIST_Certified* | 18.8 ± 0.8 | moraine boulder | 9 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WTO-3B | 45.325 | -117.222 | 1466 | 1.75 | 2.8 | 1 | 265000 | 15000 | NIST_Certified* | 16.0 ± 0.9 | moraine boulder | 9 |
| WTO-4A | 45.326 | -117.223 | 1460 | 1.75 | 2.8 | 1 | 297000 | 13000 | NIST_Certified* | 18.1 ± 0.8 | moraine boulder | 9 |
| WTO-5A | 45.326 | -117.223 | 1454 | 1.75 | 2.8 | 1 | 282000 | 10000 | NIST_Certified* | 17.2 ± 0.6 | moraine boulder | 9 |
| WTO-9B | 45.327 | -117.216 | 1405 | 2 | 2.8 | 1 | 260000 | 16000 | NIST_Certified* | 16.5 ± 1.0 | moraine boulder | 9 |
| *Glacier Lake moraine* | | | | | | | | | | | | |
| GL-1 | 45.158 | -117.283 | 2512 | 1.5 | 2.8 | 1 | 363000 | 15000 | NIST_Certified* | 10.5 ± 0.4 | moraine boulder | 9 |
| GL-3 | 45.159 | -117.284 | 2509 | 1.5 | 2.8 | 1 | 301000 | 12000 | NIST_Certified* | 8.7 ± 0.3 | moraine boulder | 9 |
| GL-5 | 45.16 | -117.285 | 2504 | 2.5 | 2.8 | 1 | 324000 | 20000 | NIST_Certified* | 9.5 ± 0.6 | moraine boulder | 9 |
| GL-5C | 45.16 | -117.285 | 2504 | 2.5 | 2.8 | 1 | 348000 | 19000 | NIST_Certified* | 10.2 ± 0.6 | moraine boulder | 9 |
| GL-6C | 45.16 | -117.285 | 2503 | 1.5 | 2.8 | 1 | 426000 | 35000 | NIST_Certified* | 12.4 ± 1.0 | moraine boulder | 9 |
| GL-7B | 45.16 | -117.284 | 2502 | 1 | 2.8 | 1 | 351000 | 19000 | NIST_Certified* | 10.2 ± 0.6 | bedrock | 9 |
| Gl-7C | 45.16 | -117.284 | 2502 | 1 | 2.8 | 1 | 344000 | 32000 | NIST_Certified* | 10.0 ± 0.9 | bedrock | 9 |
| ***Fremont/Titcomb, WRR, Wymoing*** | | | | | | | | | | | | |
| *Fremont terminal moraine* | | | | | | | | | | | | |
| 92-108-1 | 42.90 | -109.85 | 2274 | 2 | 2.7 | 1 | 676000 | 20280 | KNSTD | 24.3 ± 0.7 | moraine boulder | 10 |
| 91-032 | 42.90 | -109.85 | 2311 | 5 | 2.7 | 1 | 685000 | 20550 | KNSTD | 24.7 ± 0.7 | moraine boulder | 10 |
| 91-35 | 42.90 | -109.85 | 2262 | 2 | 2.7 | 1 | 625000 | 18750 | KNSTD | 22.7 ± 0.7 | moraine boulder | 10 |
| *Soda Lake moraine* | | | | | | | | | | | | |
| 91-003 | 42.93 | -110 | 2276 | 14 | 2.7 | 1 | 518000 | 15500 | KNSTD | 20.5 ± 0.6 | moraine boulder | 10 |
| 91-004 | 42.93 | -109.85 | 2279 | 5 | 2.7 | 1 | 671000 | 20130 | KNSTD | 24.7 ± 0.7 | moraine boulder | 10 |
| *Half Moon moraine* | | | | | | | | | | | | |
| 92-117 | 42.91 | -109.85 | 2357 | 3 | 2.7 | 1 | 645000 | 19350 | KNSTD | 22.1 ± 0.7 | moraine boulder | 10 |
| 92-119 | 42.91 | -109.85 | 2319 | 5 | 2.7 | 1 | 609000 | 18270 | KNSTD | 21.8 ± 0.7 | moraine boulder | 10 |
| *Recessional moraines* | | | | | | | | | | | | |
| 92-123 | 42.91 | -109.85 | 2369 | 3 | 2.7 | 1 | 534000 | 16020 | KNSTD | 18.2 ± 0.5 | moraine boulder | 10 |
| 92-155 | 42.91 | -109.85 | 2375 | 2.5 | 2.7 | 1 | 535000 | 16050 | KNSTD | 18.1 ± 0.5 | moraine boulder | 10 |
| 92-129 | 42.91 | -109.85 | 2390 | 5 | 2.7 | 1 | 561000 | 16830 | KNSTD | 19.1 ± 0.6 | moraine boulder | 10 |
| 92-124 | 42.91 | -109.85 | 2337 | 5 | 2.7 | 1 | 503000 | 15090 | KNSTD | 17.8 ± 0.5 | moraine boulder | 10 |
| 91-020 | 42.90 | -109.85 | 2352 | 5 | 2.7 | 1 | 503000 | 15090 | KNSTD | 17.6 ± 0.5 | moraine boulder | 10 |
| 92-127 | 42.91 | -109.85 | 2335 | 4 | 2.7 | 1 | 504000 | 15120 | KNSTD | 17.7 ± 0.5 | moraine boulder | 10 |
| 92-130 | 42.91 | -109.85 | 2341 | 5 | 2.7 | 1 | 541000 | 16230 | KNSTD | 19.1 ± 0.6 | moraine boulder | 10 |
| 91-024 | 42.91 | -109.85 | 2323 | 10 | 2.7 | 1 | 502000 | 15060 | KNSTD | 18.7 ± 0.6 | moraine boulder | 10 |
| 92-125 | 42.91 | -109.85 | 2341 | 5 | 2.7 | 1 | 528000 | 15840 | KNSTD | 18.6 ± 0.6 | moraine boulder | 10 |
| 91-026 | 42.91 | -109.85 | 2342 | 4 | 2.7 | 1 | 468000 | 14040 | KNSTD | 16.3 ± 0.5 | moraine boulder | 10 |
| *Erratics* | | | | | | | | | | | | |
| 341-O | 43.12 | -109 | 3228 | 8.0 | 2.7 | 0.985 | 813700 | 24411 | KNSTD | 17.0 ± 0.5 | erratic | 10 |
| 343-B | 43.12 | -109 | 3226 | 4.0 | 2.7 | 0.985 | 745000 | 22350 | KNSTD | 15.1 ± 0.5 | erratic | 10 |
| 344-E | 43.11 | -109 | 3247 | 2.5 | 2.7 | 0.985 | 652000 | 19560 | KNSTD | 12.9 ± 0.4 | erratic | 10 |
| 345-B | 43.11 | -109 | 3247 | 4.0 | 2.7 | 0.985 | 728000 | 21840 | KNSTD | 14.6 ± 0.4 | erratic | 10 |
| *Titcomb Lakes moraine* | | | | | | | | | | | | |
| 138-I | 43.10 | -109.6 | 3230 | 4 | 2.7 | 0.985 | 627000 | 18810 | KNSTD | 12.7 ± 0.4 | moraine boulder | 11 |
| 139-I | 43.10 | -109.6 | 3230 | 4 | 2.7 | 0.985 | 591000 | 17730 | KNSTD | 12.0 ± 0.4 | moraine boulder | 11 |
| 333-I | 43.10 | -109.6 | 3230 | 3 | 2.7 | 0.985 | 596600 | 17898 | KNSTD | 12.0 ± 0.4 | moraine boulder | 11 |
| 334-I | 43.10 | -109.6 | 3230 | 3 | 2.7 | 0.985 | 669700 | 20091 | KNSTD | 13.5 ± 0.4 | moraine boulder | 11 |
| 335-I | 43.10 | -109.6 | 3230 | 8 | 2.7 | 0.985 | 615700 | 18471 | KNSTD | 12.9 ± 0.4 | moraine boulder | 11 |
| 336-I | 43.10 | -109.6 | 3230 | 3 | 2.7 | 0.985 | 656600 | 19698 | KNSTD | 13.2 ± 0.4 | moraine boulder | 11 |
| 337-I | 43.10 | -109.6 | 3230 | 9 | 2.7 | 0.985 | 624700 | 18741 | KNSTD | 13.2 ± 0.4 | moraine boulder | 11 |
| 338-I | 43.10 | -109.6 | 3230 | 5 | 2.7 | 0.985 | 625100 | 18753 | KNSTD | 12.8 ± 0.4 | moraine boulder | 11 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 339-I | 43.10 | -109.6 | 3230 | 4 | 2.7 | 0.985 | 623900 | 18717 | KNSTD | 12.6 ± 0.4 | moraine boulder | 11 |
| ***<u>W Unitas, North Fork Provo, Bear, and Bald Mtn, UT</u>*** | | | | | | | | | | | | |
| *NF Provo terminal moraine* | | | | | | | | | | | | |
| NFP-1 | 40.59 | -111.09 | 2319 | 5 | 2.65 | 0.9997 | 322000 | 16000 | KNSTD | 12.1 ± 0.6 | moraine boulder | 12,13 |
| NFP-2B | 40.70 | -111.09 | 2327 | 3 | 2.65 | 0.9997 | 435000 | 15000 | KNSTD | 15.9 ± 0.6 | moraine boulder | 12,13 |
| NFP-3A | 40.70 | -111.09 | 2321 | 6 | 2.65 | 0.9997 | 481000 | 52000 | KNSTD | 18.1 ± 2.0 | moraine boulder | 12,13 |
| NFP-4A | 40.59 | -111.09 | 2324 | 5 | 2.65 | 0.9990 | 473000 | 13000 | NIST_Certified* | 17.7 ± 0.5 | moraine boulder | 12,13 |
| NFP-4B | 40.59 | -111.09 | 2324 | 2.5 | 2.65 | 0.9995 | 391000 | 19000 | KNSTD | 14.3 ± 0.7 | moraine boulder | 12,13 |
| NFP-4C | 40.59 | -111.09 | 2324 | 3 | 2.65 | 0.9995 | 375000 | 19000 | KNSTD | 13.8 ± 0.7 | moraine boulder | 12,13 |
| NFP-4D | 40.59 | -111.09 | 2324 | 3 | 2.65 | 0.9990 | 530000 | 26000 | NIST_Certified* | 19.5 ± 1.0 | moraine boulder | 12,13 |
| NFP-5 | 40.59 | -111.08 | 2346 | 3.5 | 2.65 | 1 | 446000 | 17000 | KNSTD | 16.2 ± 0.6 | moraine boulder | 12,13 |
| *Bald Mountain* | | | | | | | | | | | | |
| BMP-2 | 40.69 | -110.9 | 3277 | 5 | 2.65 | 0.997 | 678000 | 19000 | NIST_Certified* | 14.1 ± 0.4 | bedrock | 12,13 |
| BMP-4 | 40.69 | -110.9 | 3280 | 4 | 2.65 | 0.997 | 685000 | 15000 | NIST_Certified* | 14.1 ± 0.3 | bedrock | 12,13 |
| BMP-5 | 40.69 | -110.91 | 3250 | 2.5 | 2.65 | 0.998 | 776000 | 147000 | NIST_Certified* | 16.0 ± 3.0 | bedrock | 12,13 |
| BMP-7 | 40.69 | -110.91 | 3250 | 3 | 2.65 | 0.998 | 729000 | 27000 | NIST_Certified* | 15.2 ± 0.6 | bedrock | 12,13 |

[a] Reported $^{10}$Be ages using the global production rate (4.49 ± 0.39 atoms g$^{-1}$ yr$^{-1}$; normalized to 07KNSTD) and the constanct production scaling scheme of Lal (1991)/Stone (2000).
[b] depth profile consistning of multiple $^{10}$Be measurements; see source reference for details.
[c] Al-26 age
NIST_Certified* - We report $^{10}$Be concentrations provided by the original authors. Before calculating $^{10}$Be ages, the original authors applied a 14% correction to $^{10}$Be/$^{9}$Be ratios. See source referenes for details.
References: 1-This study; 2- Schlingden, 2000; 3- Briner, 2009; 4- Guido et al., 2007; 5- Ward et al., 2009; 6- Benson et al., 2005; 7- Licciardi and Pierce, 2008; 8- Licciardi et al., 2001; 9- Licciardi et al., 2004; 10- Gosse et al., 1995a; 11- Gosse et al., 1995b; 12- Refsnider et al., 2008; 13- Laabs et al., 2009

*Table DR2. Western US cosmogenic exposure ages*

| Sample | St | De | Du | Li | St (mag) | NE Li | NE St | NE De | NE Du | NE St (mag) |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Lake Creek, CO*** | | | | | | | | | | |
| AR09-01 | 14.7 ± 0.4 | 14.0 ± 0.4 | 13.9 ± 0.4 | 13.6 ± 0.4 | 14.5 ± 0.4 | 14.7 ± 0.4 | 16.7 ± 0.4 | 14.9 ± 0.4 | 14.8 ± 0.4 | 16.3 ± 0.4 |
| AR09-10 | 13.9 ± 0.4 | 13.1 ± 0.4 | 13.1 ± 0.4 | 12.7 ± 0.4 | 13.7 ± 0.4 | 13.8 ± 0.4 | 15.8 ± 0.4 | 14.0 ± 0.4 | 13.9 ± 0.4 | 15.8 ± 0.4 |
| AR09-11 | 13.2 ± 0.3 | 12.3 ± 0.3 | 12.3 ± 0.3 | 11.9 ± 0.3 | 13.0 ± 0.3 | 12.9 ± 0.3 | 15.1 ± 0.3 | 15.1 ± 0.3 | 15.1 ± 0.3 | 15.4 ± 0.3 |
| DC-91-2 | 19.7 ± 0.5 | 18.6 ± 0.5 | 18.4 ± 0.5 | 18.0 ± 0.5 | 19.2 ± 0.5 | 19.5 ± 0.6 | 22.4 ± 0.6 | 19.8 ± 0.6 | 19.5 ± 0.6 | 21.6 ± 0.6 |
| ***Clear Creek, CO*** | | | | | | | | | | |
| MF06-01 | 19.5 ± 0.6 | 18.3 ± 0.6 | 18.1 ± 0.6 | 17.8 ± 0.6 | 19.0 ± 0.6 | 19.2 ± 0.7 | 22.2 ± 0.7 | 19.5 ± 0.7 | 19.2 ± 0.7 | 21.3 ± 0.7 |
| MF06-02 | 19.3 ± 0.4 | 18.1 ± 0.4 | 18.0 ± 0.4 | 17.6 ± 0.4 | 18.8 ± 0.4 | 19.0 ± 0.5 | 22.0 ± 0.5 | 19.3 ± 0.5 | 19.1 ± 0.5 | 21.2 ± 0.5 |
| MF06-03 | 21.7 ± 0.6 | 20.2 ± 0.6 | 20.0 ± 0.6 | 19.7 ± 0.6 | 21.0 ± 0.6 | 21.2 ± 0.6 | 24.7 ± 0.6 | 21.5 ± 0.6 | 21.2 ± 0.6 | 23.6 ± 0.6 |
| MF06-04 | 19.1 ± 0.4 | 17.9 ± 0.4 | 17.7 ± 0.4 | 17.4 ± 0.4 | 18.6 ± 0.4 | 18.8 ± 0.4 | 21.7 ± 0.4 | 19.1 ± 0.4 | 18.8 ± 0.4 | 20.9 ± 0.4 |
| MF06-05 | 15.2 ± 0.4 | 14.4 ± 0.4 | 14.4 ± 0.4 | 14.0 ± 0.4 | 15.0 ± 0.4 | 15.2 ± 0.5 | 17.4 ± 0.5 | 15.4 ± 0.5 | 15.2 ± 0.5 | 16.9 ± 0.5 |
| AR09-03 | 14.1 ± 0.3 | 13.6 ± 0.3 | 13.5 ± 0.3 | 13.2 ± 0.3 | 14.0 ± 0.3 | 14.3 ± 0.3 | 16.1 ± 0.3 | 14.5 ± 0.3 | 14.4 ± 0.3 | 15.7 ± 0.3 |
| ***Pine Creek, CO*** | | | | | | | | | | |
| PC1 | 20.9 ± 0.5 | 19.5 ± 0.5 | 19.3 ± 0.5 | 18.9 ± 0.5 | 20.3 ± 0.5 | 20.4 ± 0.6 | 23.8 ± 0.6 | 20.7 ± 0.6 | 20.5 ± 0.6 | 22.8 ± 0.6 |
| PC2 | 13.5 ± 0.4 | 12.8± 0.4 | 12.8± 0.4 | 12.5± 0.4 | 13.3 ± 0.4 | 13.5 ± 0.5 | 15.4 ± 0.5 | 13.7 ± 0.5 | 13.6 ± 0.5 | 15.0 ± 0.5 |
| PC3 | 15.6 ± 0.4 | 14.8 ± 0.4 | 14.7 ± 0.4 | 14.4 ± 0.4 | 15.3 ± 0.4 | 15.6 ± 0.5 | 17.8 ± 0.5 | 15.8 ± 0.5 | 15.6 ± 0.5 | 17.2 ± 0.5 |
| PC4 | 22.4 ± 0.5 | 20.9 ± 0.5 | 20.7 ± 0.5 | 20.3 ± 0.5 | 21.7 ± 0.5 | 21.9 ± 0.6 | 25.5 ± 0.6 | 22.3 ± 0.6 | 21.9 ± 0.6 | 24.3 ± 0.6 |
| PC5 | 24.5 ± 0.7 | 22.9 ± 0.7 | 22.6 ± 0.7 | 22.3 ± 0.7 | 23.6 ± 0.7 | 24.0 ± 0.8 | 28.0 ± 0.8 | 24.4 ± 0.8 | 24.0 ± 0.8 | 26.6 ± 0.8 |
| PC6 | 16.0 ± 0.4 | 15.3 ± 0.4 | 15.2 ± 0.4 | 14.9 ± 0.4 | 15.8 ± 0.4 | 16.0 ± 0.4 | 18.3 ± 0.4 | 16.2 ± 0.4 | 16.1 ± 0.4 | 17.7 ± 0.4 |
| PC7 | 22.8 ± 0.5 | 21.4 ± 0.5 | 21.1 ± 0.5 | 20.8 ± 0.5 | 22.1 ± 0.5 | 22.4 ± 0.6 | 26.0 ± 0.6 | 22.7 ± 0.6 | 22.4 ± 0.6 | 24.8 ± 0.6 |
| PC8 | 21.3 ± 0.4 | 20.1 ± 0.4 | 19.8 ± 0.4 | 19.5 ± 0.4 | 20.7 ± 0.4 | 21.0 ± 0.5 | 24.3 ± 0.5 | 21.3 ± 0.5 | 21.0 ± 0.5 | 23.3 ± 0.5 |
| PC9 | 15.4 ± 0.4 | 14.7 ± 0.4 | 14.6 ± 0.4 | 14.3 ± 0.4 | 15.1 ± 0.4 | 15.5 ± 0.4 | 17.5 ± 0.4 | 15.7 ± 0.4 | 15.5 ± 0.4 | 17.0 ± 0.4 |
| PC11 | 15.3 ± 0.4 | 14.7 ± 0.4 | 14.6 ± 0.4 | 14.3 ± 0.4 | 15.1 ± 0.4 | 15.4 ± 0.4 | 17.5 ± 0.4 | 15.6 ± 0.4 | 15.5 ± 0.4 | 17.0 ± 0.4 |
| PC12 | 16.2 ± 0.4 | 15.6 ± 0.4 | 15.5 ± 0.4 | 15.2 ± 0.4 | 16.0 ± 0.4 | 16.4 ± 0.4 | 18.5 ± 0.4 | 16.6 ± 0.4 | 16.4 ± 0.4 | 18.0 ± 0.4 |
| PC13 | 16.1 ± 0.4 | 15.5 ± 0.4 | 15.4 ± 0.4 | 15.1 ± 0.4 | 15.8 ± 0.4 | 16.3 ± 0.4 | 18.4 ± 0.4 | 16.5 ± 0.4 | 16.3 ± 0.4 | 17.8 ± 0.4 |
| AR09-07 | 15.6 ± 0.4 | 14.8 ± 0.4 | 14.7 ± 0.4 | 14.4 ± 0.4 | 15.3 ± 0.4 | 15.5 ± 0.5 | 17.7 ± 0.5 | 15.7 ± 0.5 | 15.6 ± 0.5 | 17.2 ± 0.5 |
| AR09-08 | 15.3 ± 0.3 | 14.6 ± 0.3 | 14.5 ± 0.3 | 14.2 ± 0.3 | 15.1 ± 0.3 | 15.3 ± 0.4 | 17.5 ± 0.4 | 15.5 ± 0.4 | 15.4 ± 0.4 | 17.0 ± 0.4 |
| ***ARK River valley, CO, Lower flood terrace*** | | | | | | | | | | |
| QPOY-01 | 17.3 ± 0.4 | 16.7 ± 0.4 | 16.6 ± 0.4 | 16.3 ± 0.4 | 17.0 ± 0.4 | 17.6 ± 0.5 | 19.7 ± 0.5 | 17.8 ± 0.5 | 17.6 ± 0.5 | 19.1 ± 0.5 |
| QPOY-02 | 17.2 ± 0.8 | 16.6 ± 0.8 | 16.5 ± 0.8 | 16.2 ± 0.8 | 16.9 ± 0.8 | 17.4 ± 0.1 | 19.6 ± 0.1 | 17.7 ± 0.1 | 17.5 ± 0.1 | 19.0 ± 0.1 |
| AR09-05 | 18.4 ± 0.4 | 17.8 ± 0.4 | 17.6± 0.4 | 17.3 ± 0.4 | 18.0 ± 0.4 | 18.7 ± 0.4 | 20.9 ± 0.4 | 18.9 ± 0.4 | 18.7 ± 0.4 | 20.2 ± 0.4 |
| AR09-06 | 18.1 ± 0.4 | 17.5 ± 0.4 | 17.3 ± 0.4 | 17.0 ± 0.4 | 17.7 ± 0.4 | 18.4 ± 0.5 | 20.6 ± 0.5 | 18.6 ± 0.5 | 18.4 ± 0.5 | 19.9 ± 0.5 |
| ***ARK River valley, CO, Upper flood terrace*** | | | | | | | | | | |
| QPOO-2 | 19.1 ± 0.8 | 18.3 ± 0.8 | 18.2 ± 0.8 | 17.9 ± 0.8 | 18.6 ± 0.8 | 19.3 ± 0.9 | 21.8 ± 0.9 | 19.5 ± 0.9 | 19.3 ± 0.9 | 20.9 ± 0.9 |
| QPOO-4 | 20.9 ± 1.0 | 20.0 ± 1.0 | 19.8 ± 1.0 | 19.4 ± 1.0 | 20.3 ± 1.0 | 21.0 ± 1.1 | 23.8 ± 1.1 | 21.3 ± 1.1 | 21.0 ± 1.1 | 22.8 ± 1.1 |
| QPOO-01 | 19.1 ± 0.6 | 18.4 ± 0.6 | 18.2 ± 0.6 | 17.9 ± 0.6 | 18.7 ± 0.6 | 19.3 ± 0.7 | 21.8 ± 0.7 | 19.6 ± 0.7 | 19.3 ± 0.7 | 21.0 ± 0.7 |
| QPOO-03 | 19.3 ± 0.5 | 18.5 ± 0.5 | 18.4 ± 0.5 | 18.1 ± 0.5 | 18.9 ± 0.5 | 19.5 ± 0.5 | 22.0 ± 0.5 | 19.7 ± 0.5 | 19.5 ± 0.5 | 21.2 ± 0.5 |
| ***Animas Valley, CO*** | | | | | | | | | | |
| Baker's Ridge | 17.5 ± 0.4 | 17.4 ± 0.4 | 17.3 ± 0.4 | 17.0 ± 0.4 | 17.1 ± 0.4 | 18.3 ± 0.5 | 19.9 ± 0.5 | 18.5 ± 0.5 | 18.3 ± 0.5 | 19.3 ± 0.5 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tacoma | 14.6 ± 0.5 | 14.5 ± 0.5 | 14.4 ± 0.5 | 14.2 ± 0.5 | 14.4 ± 0.5 | 15.3 ± 0.6 | 16.6 ± 0.6 | 15.35± 0.6 | 15.3 ± 0.6 | 16.2 ± 0.6 |
| Needleton | 15.3 ± 0.4 | 15.0 ± 0.4 | 14.9 ± 0.4 | 14.6 ± 0.4 | 15.0 ± 0.4 | 15.7 ± 0.4 | 17.4 ± 0.4 | 15.9 ± 0.4 | 15.8 ± 0.4 | 16.9 ± 0.4 |
| Silverton | 14.3 ± 0.4 | 13.8 ± 0.4 | 13.7 ± 0.4 | 13.4 ± 0.4 | 14.1 ± 0.4 | 14.5 ± 0.4 | 16.3 ± 0.4 | 14.7 ± 0.4 | 14.6 ± 0.4 | 15.8 ± 0.4 |
| Highland Mary Lake | 12.6 ± 0.5 | 11.4 ± 0.5 | 11.4 ± 0.5 | 11.0 ± 0.5 | 12.4 ± 0.5 | 12.0 ± 0.5 | 14.4 ± 0.5 | 12.2 ± 0.5 | 12.1 ± 0.5 | 14.0 ± 0.5 |
| Elk Crek | 15.6 ± 0.4 | 13.9 ± 0.4 | 13.8 ± 0.4 | 13.5 ± 0.4 | 15.2 ± 0.4 | 14.5 ± 0.5 | 17.8 ± 0.5 | 14.8 ± 0.5 | 14.7 ± 0.5 | 17.1 ± 0.5 |
| terminal outwash profile[a] | 19.4 ± 1.5 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ***<u>Middle Boulder Creek, CO</u>*** | | | | | | | | | | |
| *Terminal moraine* | | | | | | | | | | |
| 99-t74[b] | 17.8 ± 0.9 | 16.7 ± 0.9 | 16.6 ± 0.9 | 16.2 ± 0.9 | 17.4 ± 0.9 | 17.5 ± 1.9 | 20.3 ± 1.9 | 17.7 ± 1.9 | 17.6 ± 1.9 | 19.6 ± 1.9 |
| 99-t76 | 20.6 ± 0.5 | 19.2 ± 0.5 | 19.0 ± 0.5 | 18.7 ± 0.5 | 20.1 ± 0.5 | 20.2 ± 0.6 | 23.5 ± 0.6 | 20.5 ± 0.6 | 20.2 ± 0.6 | 22.6 ± 0.6 |
| 99-t76[b] | 20.5 ± 1.0 | 19.1 ± 1.0 | 18.9 ± 1.0 | 18.5 ± 1.0 | 19.9 ± 1.0 | 20.0 ± 1.1 | 23.3 ± 1.1 | 20.3 ± 1.1 | 20.1 ± 1.1 | 22.4 ± 1.1 |
| MB4J-0 | 18.2 ± 1.7 | 17.5 ± 1.7 | 17.4 ± 1.7 | 17.1 ± 1.7 | 17.9 ± 1.7 | 18.4 ± 1.9 | 20.7 ± 1.9 | 18.6 ± 1.9 | 18.4 ± 1.9 | 20.1 ± 1.9 |
| *Upvalley bedrock* | | | | | | | | | | |
| 33-JB-25 | 12.5 ± 0.4 | 11.7 ± 0.4 | 11.7 ± 0.4 | 11.3 ± 0.4 | 12.5 ± 0.4 | 12.3 ± 0.5 | 14.3 ± 0.5 | 12.5 ± 0.5 | 12.4 ± 0.5 | 13.9 ± 0.5 |
| GP4J-1 | 13.5 ± 0.4 | 12.2 ± 0.4 | 12.2 ± 0.4 | 11.8 ± 0.4 | 13.5 ± 0.4 | 12.8 ± 0.5 | 15.4 ± 0.5 | 13.1 ± 0.5 | 13.0 ± 0.5 | 15.0 ± 0.5 |
| GP4J-2 | 13.8 ± 0.4 | 12.5 ± 0.4 | 12.5 ± 0.4 | 12.1 ± 0.4 | 13.8 ± 0.4 | 13.1 ± 0.5 | 15.7 ± 0.5 | 13.4 ± 0.5 | 13.3 ± 0.5 | 15.3 ± 0.5 |
| GP4J-3 | 13.6 ± 0.5 | 12.3 ± 0.5 | 12.3 ± 0.5 | 11.9 ± 0.5 | 13.6 ± 0.5 | 12.9 ± 0.6 | 15.4 ± 0.6 | 13.1 ± 0.6 | 13.0 ± 0.6 | 15.1 ± 0.6 |
| GP4J-4 | 13.4 ± 0.4 | 12.2 ± 0.4 | 12.3 ± 0.4 | 11.8 ± 0.4 | 13.4 ± 0.4 | 12.8 ± 0.5 | 15.3 ± 0.5 | 13.0 ± 0.5 | 13.0 ± 0.5 | 14.9 ± 0.5 |
| GP4J-5 | 13.2 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 11.6 ± 0.4 | 13.2 ± 0.4 | 12.6 ± 0.5 | 15.1 ± 0.5 | 12.8 ± 0.5 | 12.8 ± 0.5 | 14.7 ± 0.5 |
| GP4J-6 | 13.3 ± 0.5 | 12.1 ± 0.5 | 12.1 ± 0.5 | 11.7 ± 0.5 | 13.3 ± 0.5 | 12.7 ± 0.6 | 15.1 ± 0.6 | 12.9 ± 0.6 | 12.8 ± 0.6 | 14.8 ± 0.6 |
| GP4J-7 | 12.0 ± 0.4 | 11.0 ± 0.4 | 10.9 ± 0.4 | 10.6 ± 0.4 | 12.0 ± 0.4 | 11.5 ± 0.4 | 13.7 ± 0.4 | 11.7 ± 0.4 | 11.7 ± 0.4 | 13.4 ± 0.4 |
| GP4J-10 | 13.8 ± 0.4 | 13.2 ± 0.4 | 13.1 ± 0.4 | 12.8 ± 0.4 | 13.8 ± 0.4 | 13.8 ± 0.4 | 15.8 ± 0.4 | 14.0 ± 0.4 | 13.9 ± 0.4 | 15.4 ± 0.4 |
| GP4J-11 | 13.1 ± 0.5 | 12.3 ± 0.5 | 12.3 ± 0.5 | 11.9 ± 0.5 | 13.1 ± 0.5 | 12.9 ± 0.5 | 14.9 ± 0.5 | 13.1 ± 0.5 | 13.0 ± 0.5 | 14.6 ± 0.5 |
| GP4J-23 | 17.8 ± 0.6 | 17.0 ± 0.6 | 16.9 ± 0.6 | 16.6 ± 0.6 | 17.8 ± 0.6 | 17.9 ± 0.7 | 20.3 ± 0.7 | 18.1 ± 0.7 | 17.9 ± 0.7 | 19.7 ± 0.7 |
| ***<u>Jenny Lake, WY</u>*** | | | | | | | | | | |
| *Outer Jenny Lake moraine* | | | | | | | | | | |
| OJEN-1 | 14.1 ± 0.3 | 14.1 ± 0.3 | 14.1 ± 0.3 | 13.7 ± 0.3 | 14.0 ± 0.3 | 14.8 ± 0.3 | 16.0 ± 0.3 | 15.0 ± 0.3 | 14.9 ± 0.3 | 15.8 ± 0.3 |
| OJEN-2 | 15.0 ± 0.4 | 15.0 ± 0.4 | 15.0 ± 0.4 | 14.6 ± 0.4 | 14.9 ± 0.4 | 15.7 ± 0.4 | 17.1 ± 0.4 | 15.9 ± 0.4 | 15.9 ± 0.4 | 16.8 ± 0.4 |
| OJEN-3 | 13.4 ± 0.3 | 13.4 ± 0.3 | 13.4 ± 0.3 | 13.1 ± 0.3 | 13.3 ± 0.3 | 14.1 ± 0.4 | 15.2 ± 0.4 | 14.3 ± 0.4 | 14.2 ± 0.4 | 15.1 ± 0.4 |
| OJEN-5 | 14.4 ± 0.3 | 14.4 ± 03 | 14.3 ± 03 | 14.0 ± 03 | 14.3 ± 03 | 15.1 ± 0.4 | 16.4 ± 0.4 | 15.3 ± 0.4 | 15.2 ± 0.4 | 16.1 ± 0.4 |
| OJEN-6 | 15.4 ± 0.4 | 15.3 ± 0.4 | 15.3 ± 0.4 | 15.0 ± 0.4 | 15.3 ± 0.4 | 16.1 ± 0.4 | 17.5 ± 0.4 | 16.3 ± 0.4 | 16.3 ± 0.4 | 17.2 ± 0.4 |
| OJEN-7 | 15.1 ± 0.4 | 15.1 ± 0.4 | 15.1 ± 0.4 | 14.7 ± 0.4 | 15.0 ± 0.4 | 15.9 ± 0.4 | 17.2 ± 0.4 | 16.1 ± 0.4 | 16.0 ± 0.4 | 16.9 ± 0.4 |
| OJEN-8 | 14.4 ± 0.4 | 14.5 ± 0.4 | 14.4 ± 0.4 | 14.1 ± 0.4 | 14.4 ± 0.4 | 15.2 ± 0.4 | 16.5 ± 0.4 | 15.4 ± 0.4 | 15.3 ± 0.4 | 16.2 ± 0.4 |
| OJEN-9 | 15.3 ± 0.4 | 15.2 ± 0.4 | 15.2 ± 0.4 | 14.9 ± 0.4 | 15.2 ± 0.4 | 16.0 ± 0.4 | 17.4 ± 0.4 | 16.2 ± 0.4 | 16.2 ± 0.4 | 17.1 ± 0.4 |
| OJEN-10 | 13.5 ± 0.3 | 13.5 ± 0.3 | 13.5 ± 0.3 | 13.1 ± 0.3 | 13.4 ± 0.3 | 14.2 ± 0.4 | 15.3 ± 0.4 | 14.4 ± 0.4 | 14.3 ± 0.4 | 15.1 ± 0.4 |
| OJEN-11 | 15.0 ± 0.6 | 15.0 ± 0.6 | 15.0 ± 0.6 | 14.6 ± 0.6 | 14.9 ± 0.6 | 15.8 ± 0.6 | 17.1 ± 0.6 | 16.0 ± 0.6 | 15.9 ± 0.6 | 16.8 ± 0.6 |
| *Inner Jenny Lake moraine* | | | | | | | | | | |
| IJEN-1 | 13.2 ± 0.3 | 13.3 ± 0.3 | 13.2 ± 0.3 | 12.9 ± 0.3 | 13.2 ± 0.3 | 14.0 ± 0.4 | 15.0 ± 0.4 | 14.1 ± 0.4 | 14.1 ± 0.4 | 14.9 ± 0.4 |
| IJEN-2 | 12.6 ± 0.4 | 12.7 ± 0.4 | 12.7 ± 0.4 | 12.3 ± 0.4 | 12.6 ± 0.4 | 13.3 ± 0.4 | 14.4 ± 0.4 | 13.5 ± 0.4 | 13.5 ± 0.4 | 14.2 ± 0.4 |
| IJEN-3 | 14.0 ± 0.3 | 14.0 ± 0.3 | 14.0 ± 0.3 | 13.7 ± 0.3 | 14.0 ± 0.3 | 14.8 ± 0.4 | 16.0 ± 0.4 | 14.9 ± 0.4 | 14.9 ± 0.4 | 15.7 ± 0.4 |
| IJEN-5 | 11.7 ± 0.3 | 11.7 ± 0.3 | 11.7 ± 0.3 | 11.4 ± 0.3 | 11.6 ± 0.3 | 12.3 ± 0.4 | 13.3 ± 0.4 | 12.5 ± 0.4 | 12.4 ± 0.4 | 13.1 ± 0.4 |
| IJEN-6 | 14.2 ± 0.2 | 14.2 ± 0.2 | 14.2 ± 0.2 | 13.8 ± 0.2 | 14.1 ± 0.2 | 15.0 ± 0.4 | 16.2 ± 0.4 | 15.1 ± 0.4 | 15.1 ± 0.4 | 15.9 ± 0.4 |
| IJEN-7 | 12.9 ± 0.3 | 13.0 ± 0.3 | 13.0 ± 0.3 | 12.6 ± 0.6 | 12.9 ± 0.3 | 13.7 ± 0.4 | 14.7 ± 0.4 | 13.8 ± 0.4 | 13.8 ± 0.4 | 14.6 ± 0.4 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| IJEN-11 | 15.0 ± 0.4 | 15.0 ± 0.4 | 15.0 ± 0.4 | 14.6 ± 0.4 | 15.0 ± 0.4 | 15.8 ± 0.4 | 17.1 ± 0.4 | 16.0 ± 0.4 | 15.9 ± 0.4 | 16.8 ± 0.4 |
| IJEN-13 | 14.2 ± 0.3 | 14.2 ± 0.3 | 14.2 ± 0.3 | 13.8 ± 0.3 | 14.2 ± 0.3 | 14.9 ± 0.4 | 16.2 ± 0.4 | 15.1 ± 0.4 | 15.1 ± 0.4 | 15.9 ± 0.4 |
| *Upvalley* | | | | | | | | | | |
| BED-1 | 13.8 ± 0.3 | 13.4 ± 0.3 | 13.4 ± 0.3 | 13.0 ± 0.3 | 13.7 ± 0.3 | 14.1 ± 0.4 | 15.7 ± 0.4 | 14.3 ± 0.4 | 14.2 ± 0.4 | 15.5 ± 0.4 |
| BED-2 | 14.8 ± 0.3 | 14.7 ± 0.3 | 14.7 ± 0.3 | 14.3 ± 0.3 | 14.7 ± 0.3 | 15.4 ± 0.3 | 16.8 ± 0.3 | 15.6 ± 0.3 | 15.6 ± 0.3 | 16.6 ± 0.3 |
| LS-1 | 12.5 ± 0.3 | 12.0 ± 0.3 | 12.0 ± 0.3 | 11.6 ± 0.3 | 12.4 ± 0.3 | 12.6 ± 0.3 | 14.2 ± 0.3 | 12.8 ± 0.3 | 12.7 ± 0.3 | 14.0 ± 0.3 |
| LS-7 | 13.5 ± 0.3 | 13.0 ± 0.3 | 13.0 ± 0.3 | 12.6 ± 0.3 | 13.4 ± 0.3 | 13.6 ± 0.5 | 15.4 ± 0.5 | 13.8 ± 0.5 | 13.8 ± 0.5 | 15.2 ± 0.5 |
| LS-8 | 12.3 ± 0.3 | 11.9 ± 0.3 | 11.9 ± 0.3 | 11.5 ± 0.3 | 12.3 ± 0.3 | 12.5 ± 0.3 | 14.1 ± 0.3 | 12.7 ± 0.3 | 12.6 ± 0.3 | 13.9 ± 0.3 |
| ***NW Yellowstone, MT, WY*** | | | | | | | | | | |
| *Eightmile terminal moraine* | | | | | | | | | | |
| 8-B2 | 14.8 ± 1.0 | 15.2 ± 1.0 | 15.3 ± 1.0 | 14.8 ± 1.0 | 14.9 ± 1.0 | 16.0 ± 1.1 | 16.9 ± 1.1 | 16.2 ± 1.1 | 16.2 ± 1.1 | 16.7 ± 1.1 |
| 8-D1 | 16.0 ± 0.9 | 16.5 ± 0.9 | 16.5 ± 0.9 | 16.0 ± 0.9 | 16.0 ± 0.9 | 17.3 ± 1.0 | 18.3 ± 1.0 | 17.5 ± 1.0 | 17.5 ± 1.0 | 18.1 ± 1.0 |
| 8-F2 | 17.6 ± 1.6 | 18.0 ± 1.6 | 18.0 ± 1.6 | 17.5 ± 1.6 | 17.5 ± 1.6 | 18.9 ± 1.8 | 20.0 ± 1.8 | 19.1 ± 1.8 | 19.1 ± 1.8 | 19.8 ± 1.8 |
| 8-G2 | 19.2 ± 1.6 | 19.6 ± 1.6 | 19.6 ± 1.6 | 19.1 ± 1.6 | 19.1 ± 1.6 | 20.6 ± 1.8 | 21.9 ± 1.8 | 20.9 ± 1.8 | 20.9 ± 1.8 | 21.5 ± 1.8 |
| 8-I1&I2 | 16.5 ± 0.7 | 17.0 ± 0.7 | 17.0 ± 0.7 | 16.5 ± 0.7 | 16.5 ± 0.7 | 17.8 ± 0.8 | 18.8 ± 0.8 | 18.1 ± 0.8 | 18.0 ± 0.8 | 18.6 ± 0.8 |
| 8-J1&J2 | 17.0 ± 1.4 | 17.4 ± 1.4 | 17.4 ± 1.4 | 17.9 ± 1.4 | 16.9 ± 1.4 | 18.3 ± 1.6 | 19.3 ± 1.6 | 18.5 ± 1.6 | 18.5 ± 1.6 | 19.1 ± 1.6 |
| 8-K1 | 16.9 ± 0.6 | 17.3 ± 0.6 | 17.3 ± 0.6 | 16.9 ± 0.6 | 16.9 ± 0.6 | 18.2 ± 0.7 | 19.2 ± 0.7 | 18.4 ± 0.7 | 18.4 ± 0.7 | 19.0 ± 0.7 |
| 8-L1&L2 | 15.6 ± 0.7 | 16.0 ± 0.7 | 16.0 ± 0.7 | 15.6 ± 0.7 | 15.6 ± 0.7 | 16.8 ± 0.8 | 17.7 ± 0.8 | 17.0 ± 0.8 | 17.0 ± 0.8 | 17.5 ± 0.8 |
| 8-M2 | 15.9 ± 0.6 | 16.3 ± 0.6 | 16.4 ± 0.6 | 15.9 ± 0.6 | 15.9 ± 0.6 | 17.2 ± 0.7 | 18.1 ± 0.7 | 17.4 ± 0.7 | 17.4 ± 0.7 | 17.9 ± 0.7 |
| *Chico moraines* | | | | | | | | | | |
| CH-1A | 14.3 ± 1.2 | 14.7 ± 1.2 | 14.7 ± 1.2 | 14.3 ± 1.2 | 14.3 ± 1.2 | 15.4 ± 1.4 | 16.3 ± 1.1 | 15.6 ± 1.1 | 15.6 ± 1.1 | 16.1 ± 1.1 |
| CH-2A | 15.5 ± 1.0 | 15.9 ± 1.0 | 15.9 ± 1.0 | 15.5 ± 1.0 | 15.5 ± 1.0 | 16.7 ± 1.1 | 17.7 ± 1.0 | 16.9 ± 1.0 | 16.9 ± 1.0 | 17.5 ± 1.0 |
| CH-3B | 15.8 ± 1.4 | 16.1 ± 1.4 | 16.1 ± 1.4 | 15.7 ± 1.4 | 15.7 ± 1.4 | 16.9 ± 1.6 | 18.0 ± 1.8 | 17.1 ± 1.8 | 17.1 ± 1.8 | 17.7 ± 1.8 |
| CH-6A | 14.3 ± 1.2 | 14.7 ± 1.2 | 14.7 ± 1.2 | 14.4 ± 1.2 | 14.4 ± 1.2 | 15.5 ± 1.4 | 16.3 ± 1.8 | 15.7 ± 1.8 | 15.7 ± 1.8 | 16.2 ± 1.8 |
| CH-6B | 13.5 ± 1.5 | 13.8 ± 1.5 | 13.9 ± 1.5 | 13.5 ± 1.5 | 13.5 ± 1.5 | 14.6 ± 1.7 | 15.3 ± 0.8 | 14.7 ± 0.8 | 14.7 ± 0.8 | 15.2 ± 0.8 |
| CH-8A | 17.6 ± 1.0 | 18.0 ± 1.0 | 18.0 ± 1.0 | 17.5 ± 1.0 | 17.6 ± 1.0 | 18.9 ± 1.2 | 20.1 ± 1.6 | 19.1 ± 1.6 | 19.1 ± 1.6 | 19.8 ± 1.6 |
| CH-9B | 16.8 ± 1.2 | 17.2 ± 1.2 | 17.2 ± 1.2 | 16.7 ± 1.2 | 16.78± 1.2 | 18.0 ± 1.3 | 19.1 ± 0.7 | 18.3 ± 0.7 | 18.3 ± 0.7 | 18.3 ± 0.7 |
| CH-10B | 18.8 ± 1.1 | 19.2 ± 1.1 | 19.2 ± 1.1 | 18.7 ± 1.1 | 18.7 ± 1.1 | 20.1 ± 1.2 | 21.4 ± 0.8 | 20.4 ± 0.8 | 20.4 ± 0.8 | 21.1 ± 0.8 |
| CH-11B | 16.0 ± 0.8 | 16.4 ± 0.8 | 16.4 ± 0.8 | 16.0 ± 0.8 | 16.0 ± 0.8 | 17.2 ± 0.9 | 18.2 ± 0.7 | 17.4 ± 0.7 | 17.4 ± 0.7 | 18.0 ± 0.7 |
| Deckards Flats moraine | | | | | | | | | | |
| DF-1A | 14.0 ± 0.6 | 14.3 ± 0.6 | 14.3 ± 0.6 | 13.9 ± 0.6 | 14.1 ± 0.6 | 15.0 ± 0.7 | 16.0 ± 0.7 | 15.2 ± 0.7 | 15.2 ± 0.7 | 15.8 ± 0.7 |
| DF-2B | 12.8 ± 1.2 | 13.0 ± 1.2 | 13.0 ± 1.2 | 12.7 ± 1.2 | 12.8 ± 1.2 | 13.8 ± 1.4 | 14.6 ± 1.4 | 13.9 ± 1.4 | 13.9 ± 1.4 | 14.5 ± 1.4 |
| DF-3B | 13.4 ± 0.9 | 13.6 ± 0.9 | 13.7 ± 0.9 | 13.3 ± 0.9 | 13.4 ± 0.9 | 14.4 ± 1.0 | 15.3 ± 1.0 | 14.5 ± 1.0 | 14.5 ± 1.0 | 15.1 ± 1.0 |
| DF-4A | 12.6 ± 1.1 | 12.9 ± 1.1 | 12.9 ± 1.1 | 12.6 ± 1.1 | 12.7 ± 1.1 | 13.6 ± 1.2 | 14.4 ± 1.2 | 13.7 ± 1.2 | 13.7 ± 1.2 | 14.3 ± 1.2 |
| DF-5B | 16.3 ± 0.7 | 16.5 ± 0.7 | 16.5 ± 0.7 | 16.1 ± 0.7 | 16.3 ± 0.7 | 17.4 ± 0.8 | 18.6 ± 0.8 | 17.6 ± 0.8 | 17.6 ± 0.8 | 18.3 ± 0.8 |
| DF-6A | 13.7 ± 0.7 | 13.9 ± 0.7 | 13.9 ± 0.7 | 13.5 ± 0.7 | 13.7 ± 0.7 | 14.6 ± 0.8 | 15.5 ± 0.8 | 14.8 ± 0.8 | 14.8 ± 0.8 | 15.4 ± 0.8 |
| DF-6B | 15.1 ± 1.1 | 15.3 ± 1.1 | 15.3 ± 1.1 | 15.0 ± 1.1 | 15.1 ± 1.1 | 16.1 ± 1.3 | 17.2 ± 1.3 | 16.3 ± 1.3 | 16.3 ± 1.3 | 17.0 ± 1.3 |
| DF-7A | 14.5 ± 0.8 | 14.8 ± 0.8 | 14.8 ± 0.8 | 14.4 ± 0.8 | 14.5 ± 0.8 | 15.5 ± 0.9 | 16.5 ± 0.9 | 15.7 ± 0.9 | 15.7 ± 0.9 | 16.4 ± 0.9 |
| DF-8A | 15.3 ± 0.9 | 15.5 ± 0.9 | 15.5 ± 0.9 | 15.1 ± 0.9 | 15.3 ± 0.9 | 16.3 ± 1.0 | 17.4 ± 1.0 | 16.5 ± 1.0 | 16.5 ± 1.0 | 17.2 ± 1.0 |
| DF-9B | 13.4 ± 0.5 | 13.6 ± 0.5 | 13.6 ± 0.5 | 13.3 ± 0.5 | 13.4 ± 0.5 | 14.3 ± 0.6 | 15.2 ± 0.6 | 14.5 ± 0.6 | 14.5 ± 0.6 | 15.1 ± 0.6 |
| DF-10A | 15.2 ± 1.9 | 15.5 ± 1.9 | 15.5 ± 1.9 | 15.1 ± 1.9 | 15.2 ± 1.9 | 16.3 ± 2.1 | 17.4 ± 2.1 | 16.5 ± 2.1 | 16.4 ± 2.1 | 17.2 ± 2.1 |
| *Junction Butte moraine* | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| JB-1 | 14.7 ± 0.3 | 14.8 ± 0.3 | 14.7 ± 0.3 | 14.7 ± 0.3 | 14.7 ± 0.3 | 15.5 ± 0.4 | 16.7 ± 0.4 | 15.7 ± 0.4 | 15.7 ± 0.4 | 16.5 ± 0.4 |
| JB-2 | 14.3 ± 0.3 | 14.5 ± 0.3 | 14.3 ± 0.3 | 14.3 ± 0.3 | 14.3 ± 0.3 | 15.2 ± 0.4 | 16.3 ± 0.4 | 15.4 ± 0.4 | 15.4 ± 0.4 | 16.1 ± 0.4 |
| JB-4 | 14.1 ± 0.3 | 14.3 ± 0.3 | 14.1 ± 0.3 | 14.1 ± 0.3 | 14.1 ± 0.3 | 15.0 ± 0.3 | 16.1 ± 0.3 | 15.2 ± 0.3 | 15.2 ± 0.3 | 15.9 ± 0.3 |
| JB-7 | 14.2 ± 0.3 | 14.4 ± 0.3 | 14.2 ± 0.3 | 14.2 ± 0.3 | 14.2 ± 0.3 | 15.1 ± 0.4 | 16.2 ± 0.4 | 15.3 ± 0.4 | 15.3 ± 0.4 | 16.0 ± 0.4 |
| JB-8 | 13.0 ± 0.4 | 13.2 ± 0.4 | 13.0 ± 0.4 | 13.0 ± 0.4 | 13.0 ± 0.4 | 13.8 ± 0.4 | 14.8 ± 0.4 | 14.0 ± 0.4 | 14.0 ± 0.4 | 14.7 ± 0.4 |
| JB-11 | 14.4 ± 0.4 | 14.5 ± 0.4 | 14.4 ± 0.4 | 14.4 ± 0.4 | 14.4 ± 0.4 | 15.3 ± 0.4 | 16.4 ± 0.4 | 15.5 ± 0.4 | 15.5 ± 0.4 | 16.2 ± 0.4 |
| ***Wallowa, OR*** | | | | | | | | | | |
| *TTO terminal moraine* | | | | | | | | | | |
| TTO-2B | 21.0 ± 0.9 | 21.4 ± 0.9 | 21.4 ± 0.9 | 20.8 ± 0.9 | 20.8 ± 0.9 | 22.5 ± 1.1 | 23.9 ± 1.1 | 22.8 ± 1.1 | 22.8 ± 1.1 | 23.5 ± 1.1 |
| TTO-3B | 21.7 ± 0.7 | 22.1 ± 0.7 | 22.1 ± 0.7 | 21.5 ± 0.7 | 21.5 ± 0.7 | 23.2 ± 0.8 | 24.7 ± 0.8 | 23.5 ± 0.8 | 23.5 ± 0.8 | 24.2 ± 0.8 |
| TTO-7A | 21.7 ± 1.6 | 22.1 ± 1.6 | 22.1 ± 1.6 | 21.5 ± 1.6 | 21.5 ± 1.6 | 23.2 ± 1.8 | 24.7 ± 1.8 | 23.5 ± 1.8 | 23.5 ± 1.8 | 24.3 ± 1.8 |
| TTO-9B | 20.7 ± 1.2 | 21.1 ± 1.2 | 21.2 ± 1.2 | 20.6 ± 1.2 | 20.6 ± 1.2 | 22.2 ± 1.3 | 23.6 ± 1.3 | 22.5 ± 1.3 | 22.5 ± 1.3 | 23.2 ± 1.3 |
| TTO-10B | 23.1 ± 1.4 | 23.5 ± 1.4 | 23.5 ± 1.4 | 22.8 ± 1.4 | 23.9 ± 1.4 | 24.6 ± 1.6 | 26.3 ± 1.6 | 25.0 ± 1.6 | 25.0 ± 1.6 | 25.7 ± 1.6 |
| TTO-11A | 22.3 ± 1.3 | 22.8 ± 1.3 | 22.8 ± 1.3 | 22.2 ± 1.3 | 22.1 ± 1.3 | 23.9 ± 1.4 | 25.4 ± 1.4 | 24.2 ± 1.4 | 24.2 ± 1.4 | 24.9 ± 1.4 |
| *TTY end moraine* | | | | | | | | | | |
| TTY-1B | 16.7 ± 1.0 | 17.2 ± 1.0 | 17.2 ± 1.0 | 16.7 ± 1.0 | 16.7 ± 1.0 | 18.0 ± 1.2 | 19.1 ± 1.2 | 18.3 ± 1.2 | 18.3 ± 1.2 | 18.8 ± 1.2 |
| TTY-3B | 17.0 ± 1.4 | 17.5 ± 1.4 | 17.5 ± 1.4 | 17.0 ± 1.4 | 17.0 ± 1.4 | 18.4 ± 1.6 | 19.4 ± 1.6 | 18.6 ± 1.6 | 18.6 ± 1.6 | 19.2 ± 1.6 |
| TTY-6A | 16.6 ± 1.2 | 17.0 ± 1.2 | 17.0 ± 1.2 | 16.6 ± 1.2 | 16.5 ± 1.2 | 17.9 ± 1.4 | 18.9 ± 1.4 | 18.1 ± 1.4 | 18.1 ± 1.4 | 18.6 ± 1.4 |
| TTY-8A | 21.7 ± 1.6 | 22.1 ± 1.6 | 22.2 ± 1.6 | 21.6 ± 1.6 | 21.6 ± 1.6 | 23.2 ± 1.8 | 24.7 ± 1.8 | 23.6 ± 1.8 | 23.6 ± 1.8 | 24.3 ± 1.8 |
| TTY-10B | 20.9 ± 1.4 | 21.4 ± 1.4 | 21.4 ± 1.4 | 20.8 ± 1.4 | 20.8 ± 1.4 | 22.4 ± 1.6 | 23.8 ± 1.8 | 22.7 ± 1.6 | 22.7 ± 1.6 | 23.4 ± 1.8 |
| TTY-12B | 20.6 ± 1.1 | 21.0 ± 1.1 | 21.0 ± 1.1 | 20.4 ± 1.1 | 20.4 ± 1.1 | 22.1 ± 1.3 | 23.4 ± 1.3 | 22.3 ± 1.3 | 22.3 ± 1.3 | 23.0 ± 1.3 |
| TTY-13B | 16.9 ± 0.7 | 17.4 ± 0.7 | 17.5 ± 0.7 | 17.0 ± 0.7 | 16.9 ± 0.7 | 18.4 ± 0.8 | 19.3 ± 0.8 | 18.6 ± 0.8 | 18.6 ± 0.8 | 19.1 ± 0.8 |
| *WTO end moraine* | | | | | | | | | | |
| WTO-1B | 17.7 ± 0.8 | 18.2 ± 0.8 | 18.2 ± 0.8 | 17.7 ± 0.8 | 17.7 ± 0.8 | 19.1 ± 1.0 | 20.1 ± 1.0 | 19.3 ± 1.0 | 19.3 ± 1.0 | 19.9 ± 1.0 |
| WTO-1C | 18.8 ± 0.8 | 19.3 ± 0.8 | 19.4 ± 0.8 | 18.8 ± 0.8 | 18.8 ± 0.8 | 20.3 ± 1.0 | 21.5 ± 1.0 | 20.6 ± 1.0 | 20.6 ± 1.0 | 21.2 ± 1.0 |
| WTO-3B | 16.0 ± 0.9 | 16.5 ± 0.9 | 16.6 ± 0.9 | 16.1 ± 0.9 | 16.1 ± 0.9 | 17.4 ± 1.0 | 18.3 ± 1.0 | 17.6 ± 1.0 | 17.6 ± 1.0 | 18.1 ± 1.0 |
| WTO-4A | 18.1 ± 0.8 | 18.6 ± 0.8 | 18.6 ± 0.8 | 18.1 ± 0.8 | 18.1 ± 0.8 | 19.5 ± 0.9 | 20.6 ± 0.9 | 19.8 ± 0.9 | 19.8 ± 0.9 | 20.3 ± 0.9 |
| WTO-5A | 17.2 ± 0.6 | 17.7 ± 0.6 | 17.8 ± 0.6 | 17.3 ± 0.6 | 17.2 ± 0.6 | 18.7 ± 0.7 | 19.6 ± 0.7 | 18.9 ± 0.7 | 18.9 ± 0.7 | 19.4 ± 0.7 |
| WTO-9B | 16.5 ± 1.0 | 17.1 ± 1.0 | 17.1 ± 1.0 | 16.7 ± 1.0 | 16.5 ± 1.0 | 18.0 ± 1.2 | 18.8 ± 1.2 | 18.2 ± 1.2 | 18.2 ± 1.2 | 18.6 ± 1.2 |
| *Glacier Lake moraine* | | | | | | | | | | |
| GL-1 | 10.5 ± 0.4 | 10.3 ± 0.4 | 10.4 ± 0.4 | 10.0 ± 0.4 | 10.5 ± 0.4 | 10.8 ± 0.5 | 12.0 ± 0.5 | 11.0 ± 0.5 | 11.0 ± 0.5 | 11.9 ± 0.5 |
| GL-3 | 8.7 ± 0.3 | 8.6 ± 0.3 | 8.6 ± 0.3 | 8.3 ± 0.3 | 8.7 ± 0.3 | 9.0 ± 0.4 | 9.9 ± 0.4 | 9.2 ± 0.4 | 9.2 ± 0.4 | 9.8 ± 0.4 |
| GL-5 | 9.5 ± 0.6 | 9.4 ± 0.6 | 9.4 ± 0.6 | 9.0 ± 0.6 | 9.5 ± 0.6 | 9.8 ± 0.7 | 10.8 ± 0.7 | 10.0 ± 0.7 | 10.0 ± 0.7 | 10.7 ± 0.7 |
| GL-5C | 10.2 ± 0.6 | 10.1 ± 0.6 | 10.1 ± 0.6 | 9.7 ± 0.6 | 10.2 ± 0.6 | 10.5 ± 0.6 | 11.6 ± 0.6 | 10.7 ± 0.6 | 10.7 ± 0.6 | 11.5 ± 0.6 |
| GL-6C | 12.4 ± 1.0 | 12.2 ± 1.0 | 12.2 ± 1.0 | 11.8 ± 1.0 | 12.4 ± 1.0 | 12.8 ± 1.2 | 14.1 ± 1.2 | 13.0 ± 1.2 | 13.0 ± 1.2 | 14.0 ± 1.2 |
| GL-7B | 10.2 ± 0.6 | 10.0 ± 0.6 | 10.1 ± 0.6 | 9.7 ± 0.6 | 10.2 ± 0.6 | 10.5 ± 0.6 | 11.6 ± 0.6 | 10.7 ± 0.6 | 10.7 ± 0.6 | 11.5 ± 0.6 |
| Gl-7C | 10.0 ± 0.9 | 9.8 ± 0.9 | 9.9 ± 0.9 | 9.5 ± 0.9 | 10.0 ± 0.9 | 10.3 ± 1.1 | 11.4 ± 1.1 | 10.5 ± 1.1 | 10.5 ± 1.1 | 11.3 ± 1.1 |
| ***Fremont/Titcomb, WRR, Wymoing*** | | | | | | | | | | |
| *Fremont terminal moraine* | | | | | | | | | | |
| 92-108-1 | 24.3 ± 0.7 | 23.6 ± 0.7 | 23.5 ± 0.7 | 23.0 ± 0.7 | 23.8 ± 0.7 | 24.7 ± 0.8 | 27.8 ± 0.8 | 25.1 ± 0.8 | 24.9 ± 0.8 | 26.8 ± 0.8 |
| 91-032 | 24.7 ± 0.7 | 23.9 ± 0.7 | 23.7 ± 0.7 | 23.2 ± 0.7 | 24.1 ± 0.7 | 25.0 ± 0.9 | 28.1 ± 0.9 | 25.4 ± 0.9 | 25.2 ± 0.9 | 27.1 ± 0.9 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 91-35 | 22.7 ± 0.7 | 22.1 ± 0.7 | 22.0 ± 0.7 | 21.5 ± 0.7 | 22.2 ± 0.7 | 23.2 ± 0.8 | 25.9 ± 0.8 | 23.5 ± 0.8 | 23.3 ± 0.8 | 25.0 ± 0.8 |
| *Soda Lake moraine* | | | | | | | | | | |
| 91-003 | 20.5 ± 0.6 | 20.1 ± 0.6 | 20.0 ± 0.6 | 19.5 ± 0.6 | 20.2 ± 0.6 | 21.1 ± 0.7 | 23.4 ± 0.7 | 21.3 ± 0.7 | 21.2 ± 0.7 | 22.7 ± 0.7 |
| 91-004 | 24.7 ± 0.7 | 23.9 ± 0.7 | 23.8 ± 0.7 | 23.3 ± 0.7 | 24.1 ± 0.7 | 25.1 ± 0.9 | 28.1 ± 0.9 | 25.4 ± 0.9 | 25.3 ± 0.9 | 27.1 ± 0.9 |
| *Half Moon moraine* | | | | | | | | | | |
| 92-117 | 22.1 ± 0.7 | 21.5 ± 0.7 | 21.4 ± 0.7 | 20.9 ± 0.7 | 21.7 ± 0.7 | 22.5 ± 0.8 | 25.2 ± 0.8 | 22.8 ± 0.8 | 22.7 ± 0.8 | 24.4 ± 0.8 |
| 92-119 | 21.8 ± 0.7 | 21.2 ± 0.7 | 21.1 ± 0.7 | 20.6 ± 0.7 | 21.4 ± 0.7 | 22.3 ± 0.8 | 24.9 ± 0.8 | 22.6 ± 0.8 | 22.4 ± 0.8 | 24.1 ± 0.8 |
| Recessional moraines | | | | | | | | | | |
| 92-123 | 18.2 ± 0.5 | 17.7 ± 0.5 | 17.7 ± 0.5 | 17.3 ± 0.5 | 17.9 ± 0.5 | 18.6 ± 0.6 | 20.7 ± 0.6 | 18.9 ± 0.6 | 18.8 ± 0.6 | 20.2 ± 0.6 |
| 92-155 | 18.1 ± 0.5 | 17.6 ± 0.5 | 17.5 ± 0.5 | 17.2 ± 0.5 | 17.8 ± 0.5 | 18.5 ± 0.6 | 20.6 ± 0.6 | 18.8 ± 0.6 | 18.6 ± 0.6 | 20.1 ± 0.6 |
| 92-129 | 19.1 ± 0.6 | 18.6 ± 0.6 | 18.5 ± 0.6 | 18.1 ± 0.6 | 18.9 ± 0.6 | 19.6 ± 0.7 | 21.8 ± 0.7 | 19.8 ± 0.7 | 19.7 ± 0.7 | 21.3 ± 0.7 |
| 92-124 | 17.8 ± 0.5 | 17.4 ± 0.5 | 17.3 ± 0.5 | 16.9 ± 0.5 | 17.5 ± 0.5 | 18.3 ± 0.6 | 20.3 ± 0.6 | 18.5 ± 0.6 | 18.4 ± 0.6 | 19.8 ± 0.6 |
| 91-020 | 17.6 ± 0.5 | 17.2 ± 0.5 | 17.1 ± 0.5 | 16.8 ± 0.5 | 17.4 ± 0.5 | 18.1 ± 0.6 | 20.1 ± 0.6 | 18.3 ± 0.6 | 18.2 ± 0.6 | 19.6 ± 0.6 |
| 92-127 | 17.7 ± 0.5 | 17.3 ± 0.5 | 17.2 ± 0.5 | 16.9 ± 0.5 | 17.5 ± 0.5 | 18.2 ± 0.6 | 20.2 ± 0.6 | 18.4 ± 0.6 | 18.3 ± 0.6 | 19.7 ± 0.6 |
| 92-130 | 19.1 ± 0.6 | 18.6 ± 0.6 | 18.5 ± 0.6 | 18.1 ± 0.6 | 18.8 ± 0.6 | 19.6 ± 0.7 | 21.7 ± 0.7 | 19.8 ± 0.7 | 19.7 ± 0.7 | 21.2 ± 0.7 |
| 91-024 | 18.7 ± 0.6 | 18.2 ± 0.6 | 18.2 ± 0.6 | 17.8 ± 0.6 | 18.4 ± 0.6 | 19.2 ± 0.6 | 21.3 ± 0.6 | 19.4 ± 0.6 | 19.3 ± 0.6 | 20.7 ± 0.6 |
| 92-125 | 18.6 ± 0.6 | 18.2 ± 0.6 | 18.1 ± 0.6 | 17.7 ± 0.6 | 18.3 ± 0.6 | 19.1 ± 0.6 | 21.2 ± 0.6 | 19.4 ± 0.6 | 19.2 ± 0.6 | 20.7 ± 0.6 |
| 91-026 | 16.3 ± 0.5 | 16.0 ± 0.5 | 16.0 ± 0.5 | 15.6 ± 0.5 | 16.2 ± 0.5 | 16.9 ± 0.6 | 18.6 ± 0.6 | 17.1 ± 0.6 | 17.0 ± 0.6 | 18.2 ± 0.6 |
| *Erratics* | | | | | | | | | | |
| 341-O | 17.0 ± 0.5 | 15.7 ± 0.5 | 15.6 ± 0.5 | 15.3 ± 0.5 | 16.8 ± 0.5 | 16.5 ± 0.6 | 19.4 ± 0.6 | 16.7 ± 0.6 | 16.6 ± 0.6 | 18.9 ± 0.6 |
| 343-B | 15.1 ± 0.5 | 14.0 ± 0.5 | 13.9 ± 0.5 | 13.6 ± 0.5 | 14.9 ± 0.5 | 14.7 ± 0.5 | 17.2 ± 0.5 | 14.9 ± 0.5 | 14.8 ± 0.5 | 16.8 ± 0.5 |
| 344-E | 12.9 ± 0.4 | 12.0 ± 0.4 | 11.9 ± 0.4 | 11.6 ± 0.4 | 12.8 ± 0.4 | 12.5 ± 0.4 | 14.7 ± 0.4 | 12.8 ± 0.4 | 12.7 ± 0.4 | 14.4 ± 0.4 |
| 345-B | 14.6 ± 0.4 | 13.5 ± 0.4 | 13.4 ± 0.4 | 13.1 ± 0.4 | 14.4 ± 0.4 | 14.2 ± 0.5 | 16.6 ± 0.5 | 14.4 ± 0.5 | 14.3 ± 0.5 | 16.3 ± 0.5 |
| Titcomb Lakes moraine | | | | | | | | | | |
| 138-I | 12.7 ± 0.4 | 12.7 ± 0.4 | 12.7 ± 0.4 | 12.7 ± 0.4 | 12.7 ± 0.4 | 12.4 ± 0.4 | 14.5 ± 0.4 | 12.6 ± 0.4 | 12.5 ± 0.4 | 14.2 ± 0.4 |
| 139-I | 12.0 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 11.7 ± 0.4 | 13.6 ± 0.4 | 11.9 ± 0.4 | 11.8 ± 0.4 | 13.4 ± 0.4 |
| 333-I | 12.0 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 12.0 ± 0.4 | 11.7 ± 0.4 | 13.7 ± 0.4 | 11.9 ± 0.4 | 11.8 ± 0.4 | 13.4 ± 0.4 |
| 334-I | 13.5 ± 0.4 | 13.5 ± 0.4 | 13.5 ± 0.4 | 13.5 ± 0.4 | 13.5 ± 0.4 | 13.1 ± 0.5 | 15.3 ± 0.5 | 13.3 ± 0.5 | 13.8 ± 0.5 | 15.1 ± 0.5 |
| 335-I | 12.9 ± 0.4 | 12.9 ± 0.4 | 12.9 ± 0.4 | 12.9 ± 0.4 | 12.9 ± 0.4 | 12.6 ± 0.4 | 14.7 ± 0.4 | 12.8 ± 0.4 | 12.7 ± 0.4 | 14.4 ± 0.4 |
| 336-I | 13.2 ± 0.4 | 13.2 ± 0.4 | 13.2 ± 0.4 | 13.2 ± 0.4 | 13.2 ± 0.4 | 12.8 ± 0.5 | 15.0 ± 0.5 | 13.1 ± 0.5 | 13.0 ± 0.5 | 14.8 ± 0.5 |
| 337-I | 13.2 ± 0.4 | 13.2 ± 0.4 | 13.2 ± 0.4 | 13.2 ± 0.4 | 13.2 ± 0.4 | 12.8 ± 0.5 | 15.0 ± 0.5 | 13.1 ± 0.5 | 13.0 ± 0.5 | 14.8 ± 0.5 |
| 338-I | 12.8 ± 0.4 | 12.8 ± 0.4 | 12.8 ± 0.4 | 12.8 ± 0.4 | 12.8 ± 0.4 | 12.4 ± 0.4 | 14.6 ± 0.4 | 12.7 ± 0.4 | 12.6 ± 0.4 | 14.3 ± 0.4 |
| 339-I | 12.6 ± 0.4 | 12.6 ± 0.4 | 12.6 ± 0.4 | 12.6 ± 0.4 | 12.6 ± 0.4 | 12.3 ± 0.4 | 14.4 ± 0.4 | 12.5 ± 0.4 | 12.5 ± 0.4 | 14.2 ± 0.4 |
| ***W Unitas, North Fork Provo, Bear, and Bald Mtn, UT*** | | | | | | | | | | |
| *NF Provo terminal moraine* | | | | | | | | | | |
| NFP-1 | 12.1 ± 0.6 | 12.0 ± 0.6 | 12.0 ± 0.6 | 11.7 ± 0.6 | 12.0 ± 0.6 | 12.6 ± 0.7 | 13.7 ± 0.7 | 12.8 ± 0.7 | 12.7 ± 0.7 | 13.7 ± 0.7 |
| NFP-2B | 15.9 ± 0.6 | 15.7 ± 0.6 | 15.6 ± 0.6 | 15.3 ± 0.6 | 15.8 ± 0.6 | 16.5 ± 0.6 | 18.2 ± 0.6 | 16.7 ± 0.6 | 16.6 ± 0.6 | 17.7 ± 0.6 |
| NFP-3A | 18.1 ± 2.0 | 17.8 ± 2.0 | 17.7 ± 2.0 | 17.4 ± 2.0 | 17.8 ± 2.0 | 18.7 ± 2.2 | 20.7 ± 2.2 | 18.9 ± 2.2 | 18.8 ± 2.2 | 20.1 ± 2.2 |
| NFP-4A | 17.7 ± 0.5 | 17.4 ± 0.5 | 17.3 ± 0.5 | 17.0 ± 0.5 | 17.4 ± 0.5 | 18.3 ± 0.6 | 20.2 ± 0.6 | 18.5 ± 0.6 | 18.3 ± 0.6 | 19.6 ± 0.6 |
| NFP-4B | 14.3 ± 0.7 | 14.2 ± 0.7 | 14.1 ± 0.7 | 13.9 ± 0.7 | 14.2 ± 0.7 | 15.0 ± 0.8 | 16.3 ± 0.8 | 15.1 ± 0.8 | 15.0 ± 0.8 | 16.0 ± 0.8 |
| NFP-4C | 13.8 ± 0.7 | 13.7 ± 0.7 | 13.6 ± 0.7 | 13.4 ± 0.7 | 13.7 ± 0.7 | 14.4 ± 0.8 | 15.7 ± 0.8 | 14.6 ± 0.8 | 14.5 ± 0.8 | 15.4 ± 0.8 |
| NFP-4D | 19.5 ± 1.0 | 19.1 ± 1.0 | 19.0 ± 1.0 | 18.6 ± 1.0 | 19.2 ± 1.0 | 20.1 ± 1.1 | 22.3 ± 1.1 | 20.3 ± 1.1 | 20.1 ± 1.1 | 21.6 ± 1.1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NFP-5 | 16.2 ± 0.6 | 16.0 ± 0.6 | 15.9 ± 0.6 | 15.6 ± 0.6 | 16.0 ± 0.6 | 16.8 ± 0.7 | 18.5 ± 0.7 | 17.0 ± 0.7 | 16.9 ± 0.7 | 18.1 ± 0.7 |
| *Bald Mountain* | | | | | | | | | | |
| BMP-2 | 14.1 ± 0.4 | 13.1 ± 0.4 | 13.1 ± 0.4 | 12.7 ± 0.4 | 13.9 ± 0.4 | 13.8 ± 0.5 | 16.1 ± 0.5 | 14.0 ± 0.5 | 13.9 ± 0.5 | 15.7 ± 0.5 |
| BMP-4 | 14.1 ± 0.3 | 13.1 ± 0.3 | 13.1 ± 0.3 | 12.7 ± 0.3 | 14.0 ± 0.3 | 13.8 ± 0.4 | 16.1 ± 0.4 | 14.0 ± 0.4 | 13.9 ± 0.4 | 15.7 ± 0.4 |
| BMP-5 | 16.0 ± 3.0 | 14.9 ± 3.0 | 14.8 ± 3.0 | 14.5 ± 3.0 | 15.8 ± 3.0 | 15.6 ± 3.3 | 18.3 ± 3.3 | 15.8 ± 3.3 | 15.7 ± 3.3 | 17.8 ± 3.3 |
| BMP-7 | 15.2 ± 0.6 | 14.1 ± 0.6 | 14.0 ± 0.6 | 13.7 ± 0.6 | 15.0 ± 0.6 | 14.8 ± 0.6 | 17.3 ± 0.6 | 15.0 ± 0.6 | 14.9 ± 0.6 | 16.8 ± 0.6 |

[a] Be-10 depth profile consisting of multiple measurements; see source referece for details

[b] Al-26 age

Scaling schemes: St - Lal (199)/Stone (2000); De - Desilets and others (2003, 2006); Du - Dunai (2001); Li - Lifton et al., (2005); St (mag) - Lal (1991)/ Stone (2000) time dependent; NE Li - uses the Northeast North America $^{10}Be$ calibration of Balco et al., (2009) and scaling scheme of Lifton et al., (2005; Li), resulting in a North America $^{10}Be$ production rate of 4.50 ± 0.22 atoms $g^{-1}$ $yr^{-1}$

*Table DR3. Cosmogenic exposure ages and normalized distance calculations*

| Location and feature (#=number of ages) | Age (ka) | Uncertainty (ka) | distance from cirque headwall (km) | normalized distance |
|---|---|---|---|---|
| *Pine Creek, CO (Briner, 2009; this study)* | | | | |
| terminal moraine old mode (5) | 22.4 | 1.4 | 17.1 | 1.00 |
| terminal moraine young mode (7) | 15.8 | 0.4 | 17.1 | 1.00 |
| bedrock (2) | 15.4 | 0.2 | 13.5 | 0.79 |
| *Clear Creek, CO (this study)* | | | | |
| terminal moraine (3) | 19.3 | 0.2 | 26.7 | 1.00 |
| bedrock (1) | 14.1 | 0.3 | 17.4 | 0.65 |
| *Lake Creek, CO (Schilgden, 2000; this study)* | | | | |
| Terminal moraine (1) | 19.7 | 0.5 | 31.2 | 1.00 |
| bedrock (1) | 14.7 | 0.4 | 20.7 | 0.66 |
| bedrock (1) | 13.9 | 0.4 | 15 | 0.48 |
| bedrock (1) | 13.2 | 0.3 | 6.6 | 0.21 |
| *Animas River valley, CO (Guido et al., 2007; Ward et al., 2009)* | | | | |
| terminal outwash profile | 19.4 | 1.5 | 82.1 | 1.00 |
| bedrock (1) | 17.5 | 1.4 | 61.9 | 0.75 |
| bedrock (1) | 14.6 | 0.5 | 51.6 | 0.63 |
| bedrock (1) | 15.3 | 0.4 | 40.3 | 0.49 |
| bedrock (1) | 15.6 | 0.4 | 2 | 0.02 |
| bedrock (1) | 14.3 | 0.4 | 21.8 | 0.27 |
| bedrock (1) | 12.6 | 0.4 | 2 | 0.02 |
| *Middle Boulder Creek, CO (Ward et al., 2009)* | | | | |
| terminarl moraine (4) | 20.3 | 2.1 | 18.6 | 1.00 |
| bedrock (1) | 17.8 | 0.6 | 11.9 | 0.64 |
| bedrock (1) | 13.8 | 0.4 | 9.4 | 0.51 |
| bedrock (1) | 13.1 | 0.5 | 6.9 | 0.37 |
| bedrock (1) | 12.5 | 0.4 | 5.4 | 0.29 |
| bedrock (1) | 12.0 | 0.4 | 2.6 | 0.14 |
| cirque bedrock (6) | 13.5 | 0.4 | 1.8 | 0.10 |
| *Jenny Lake, WY (Licciardi and Pierce, 2008)* | | | | |
| outer terminal moraine (10) | 14.6 | 0.7 | 14 | 1.00 |
| inner end moraine (8) | 13.5 | 1.1 | 13.8 | 0.99 |
| bedrock (1) | 14.8 | 0.3 | 11.1 | 0.79 |
| bedrock (1) | 13.8 | 0.3 | 3.1 | 0.22 |
| inner solitude cirque lip boulders (3) | 12.8 | 0.6 | 1.8 | 0.13 |
| *NW Yellowstone, MT, WY (Licciardi and Pierce, 2008)** | | | | |
| Eightmile terminal moraine (9) (be ages) | 16.5 | 1.4 | 111.1 | 1.00 |
| Chico end moraine (8) | 16.1 | 1.7 | 103.9 | 0.94 |
| Deckard Flats moraine (10) | 14.2 | 1.2 | 53.7 | 0.48 |
| Junction Butte moraine, young mode (6) | 14.2 | 0.4 | 23.4 | 0.21 |
| *Wallowa Mountains, OR (Licciardi et al., 2004)* | | | | |
| TTO terminal moraine (6) | 21.8 | 0.9 | 27.1 | 1.00 |
| TTY end moraine old mode (3) | 21.0 | 0.6 | 26.1 | 0.96 |
| TTY end moraine young mode (4) | 16.9 | 0.2 | 26.1 | 0.96 |
| WTO end moraine (5) | 17.3 | 0.9 | 25.1 | 0.93 |
| bedrock (1) | 11.1 | 0.6 | 0.4 | 0.01 |
| Glacier Lakes moraine (4) | 11.2 | 1.3 | 0.3 | 0.01 |
| *Freemont/Titcomb, Wind River Range, WY (Gosse et al., 1995a, b)* | | | | |
| terminal moraine #1, outermost (3) | 23.9 | 1.1 | 38.7 | 1.00 |
| all other terminal moraine #1 (15) | 20.7 | 1.8 | 38.2 | 0.99 |
| end moraine #2 (2) | 18.1 | 0.1 | 37.6 | 0.97 |
| end moraine #3 (2) | 18.5 | 0.9 | 37.4 | 0.97 |
| end moraine #4 (2?) | 17.7 | 0.1 | 36.9 | 0.95 |
| end moraine #5 (3) | 17.9 | 1.4 | 36.5 | 0.94 |
| outboard titcomb lakes boulders (4) | 14.0 | 1.2 | 5 | 0.13 |
| titcomb lakes moraine (9) | 12.7 | 0.5 | 4.6 | 0.12 |
| *Western Unita Mountains, UT (Refsnider et al., 2008; Laabs et al., 2009)*** | | | | |
| terminal moraine - North Fork Provo River (8) | 15.8 | 2.5 | | 1 |
| Bald Mtn bedrock (4) | 14.3 | 0.5 | | 0 |
| *Eastern Cascades, WA (36Cl ages; Porter and Swanson, 2008)* | | | | |
| Leavenworth I (17) | 19.1 | 3 | 19.5 | 1.00 |
| Leavenworth II (11) | 16.1 | 1.1 | 19 | 0.97 |
| Rat Creek I (6) | 13.3 | 0.8 | 7 | 0.36 |
| Rat Creek II (9) | 12.5 | 0.5 | 6.5 | 0.33 |
| *Sierra Nevada, CA (36Cl ages; Phillips et al., 1996, 2009)* | | | | |
| Tioga 3 - Bishop (11) | 17.7 | 0.7 | 23 | 1.00 |
| Tioga 4 - all ages (24) | 14.9 | 1.9 | 15.1 | 0.66 |
| Recess Peak - Bishop (summary) | 13.3 | 0.5 | 2 | 0.09 |

*Distances are from ice divide shown in Figure 1 from Licciardi and Pierce (2008).
**Measuring absolute distancse in the western Uinta Mountains are not appropriate because the ice divide and terminal moraine are in adjacent valleys.