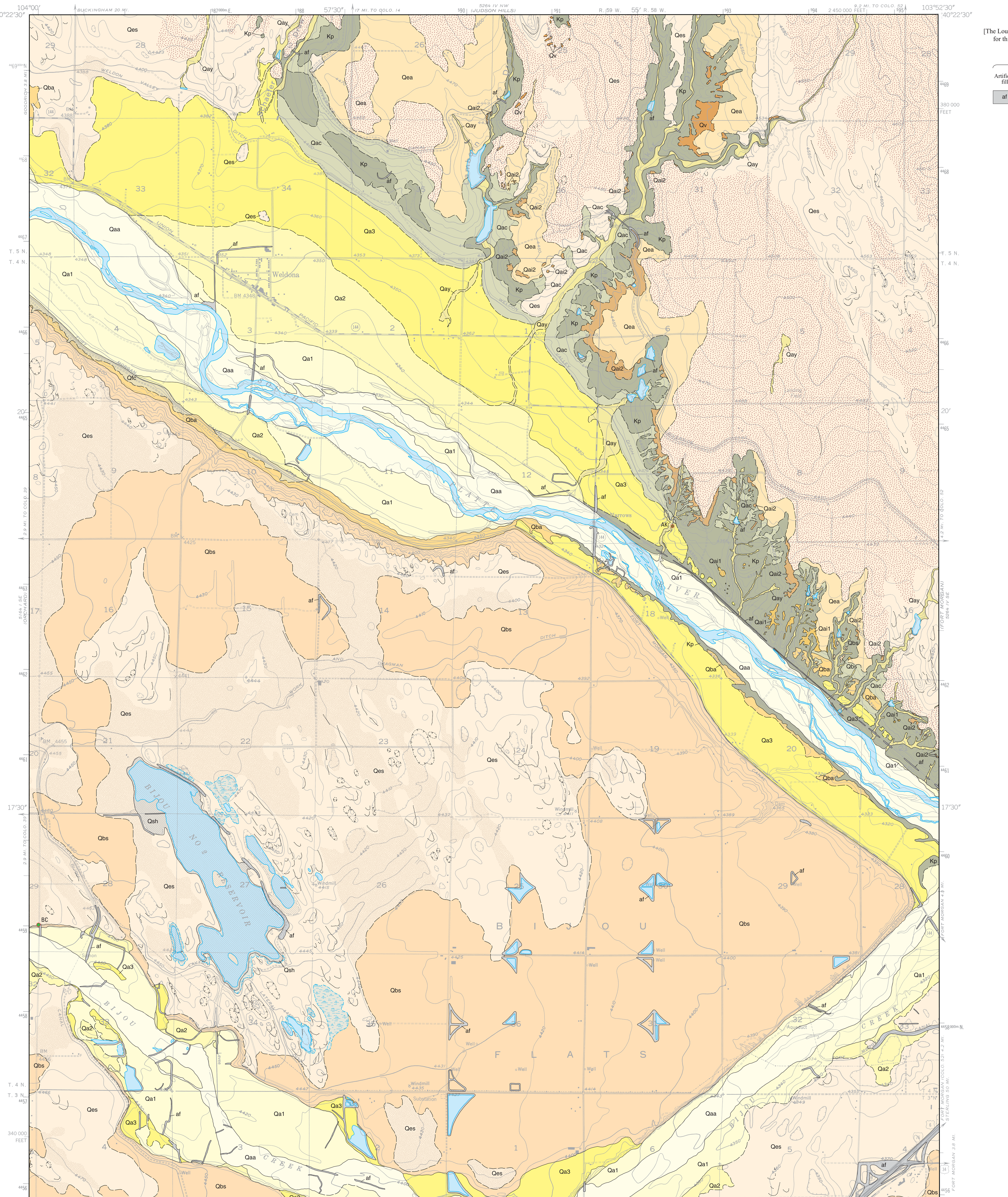
U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3396



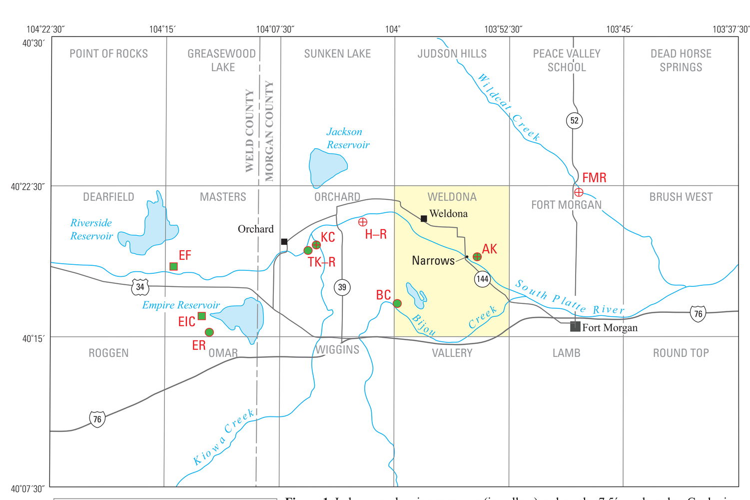



Figure 1. Index map showing map area (in yellow) and nearby 7.5′ quadrangles. Geologic maps of Orchard and Masters quadrangles published as Scientific Investigations Map 3331 and Scientific Investigations Map 3344, respectively (Berry and others, 2015a, b). Geochronology sample sites shown where green and red symbols represent the following: squares indicate $^{230}$Th/U sample sites, solid circles indicate optically stimulated luminescence sample sites, and red cross within circles indicate radiocarbon sample sites; site names (in red) link to sample field numbers (tables 1–3). The Narrows, formerly the site of a railroad post office (Elliott and Elliott, 1999), is near the start of a natural constriction of the South Platte River valley proposed as a dam site for Narrows Reservoir, which was never built (Gardner, 1967; Minges, 1983; Rogers, 2009).

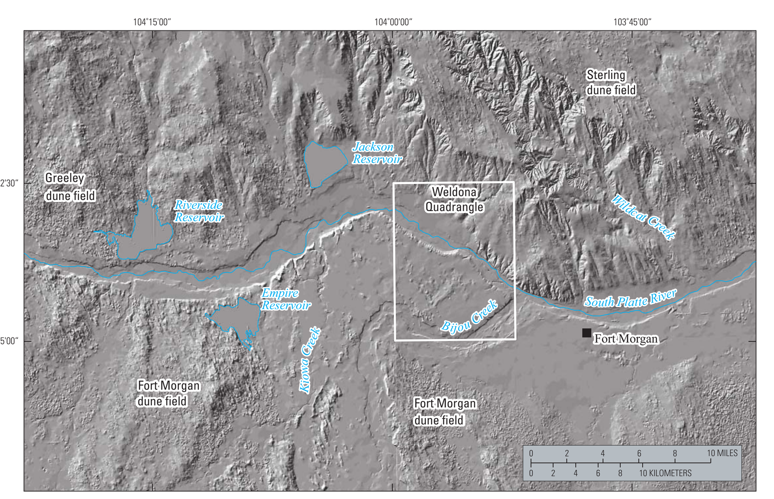


Figure 2. Shaded relief was derived from U.S. Geological Survey National Elevation Dataset (NED) with 10-meter resolution elevation data (accessed June 17, 2014, at http://ned.usgs.gov/).

# Geologic Map of the Weldona 7.5′ Quadrangle, Morgan County, Colorado

By

Margaret E. Berry,[1] Emily M. Taylor,[1] Janet L. Slate,[1] James B. Paces,[1] Paul R. Hanson,[2] and Theodore R. Brandt[1]

2018

[1]U.S. Geological Survey
[2]University of Nebraska–Lincoln, School of Natural Resources

Kp — **Pierre Shale (Upper Cretaceous)**—Upper transition member of Pierre Shale composed chiefly of marine calcareous silty shale or claystone, shaly sandstone, and sandy shale (Gardner, 1967; Scott, 1978). Mostly covered by unmapped weathered residuum; locally includes colluvium and other surficial deposits not mapped separately. Outcrops are light gray, fine-grained sandstone and shaly sandstone weathering to yellowish brown or light olive brown, and dark gray silty shale weathering to olive gray. Selenite (gypsum) crystals are common. Also contains concretionary limestone layers up to 1 m thick. In northeastern Colorado, upper transition member of Pierre Shale is reported to contain diagnostic ammonites *Sphenodiscus (Coahuilites)* sp. and *Baculites clinolobatus* (Scott, 1978). Thickness of Pierre Shale about 1,800 m in map area (Gardner, 1967; Scott, 1978)

Benson, Larry, Madole, Richard, Kubik, Peter, and McDonald, Richard, 2007, Surface-exposure ages of Front Range moraines that may have formed during the Younger Dryas, 8.2 cal ka, and Little Ice Age events: Quaternary Science Reviews, v. 26, no. 11–12, p. 1638–1649.

Benson, Larry, Madole, Richard, Landis, Gary, and Gosse, John, 2005, New data for late Pleistocene alpine glaciation from southwestern Colorado: Quaternary Science Reviews, v. 24, no. 1–2, p. 49–65.

Benson, Larry, Madole, Richard, Phillips, William, Landis, Gary, Thomas, Terry, and Kubik, Peter, 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, no. 1–2, p. 193–206.

Composite view to the southeast (3 photos) of active channel and floodplain alluvium (Qaa) exposed in north cut bank of the South Platte River downstream of the Narrows. High potassium feldspar content gives pebbly sands a distinctive pinkish hue. Grayish brown overbank sediment overlies the pebbly sands. Shovel is 68 cm long. Photographs by M.E. Berry, August 2015.

**Table 1.** *Optically stimulated luminescence (OSL) age estimates with equivalent dose ($D_e$) and dose rate data (modified from Berry and others, 2015a).*

[UNL Lab, University of Nebraska–Lincoln Luminescence Geochronology Laboratory; quad, quadrangle; UTM, Universal Transverse Mercator; Approx., approximate; m, meter; U, uranium; ppm, parts per million; Th, thorium; $K_2O$, potassium oxide; wt. %, weight percent; Gy, gray[1]; Std. err., standard error; n, number; $H_2O$, water; ka, thousand years; ±1σ, represents estimates of uncertainty given at the 67 percent confidence interval.]

| Field number | UNL lab number | 7.5′ quad | UTM Easting[2] | UTM Northing[2] | Approx. depth (m) | U (ppm) | Th (ppm) | $K_2O$ (wt.%) | CAM $D_e$ (Gy) ±1 Std. err.[3] | Aliquots (n)[4] | In situ $H_2O$ field (%)[5] | Dose rate (Gy/ka)[6] | OSL age ka±1σ[6] | In situ $H_2O$ est. (%)[5] | Dose rate (Gy/ka)[7] | OSL age ka±1σ[7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | In situ[8] | | | In situ[8] | |
| OSL–1–KC | UNL–3462 | Orchard | 577915 | 4464174 | 1.7 | 5.3 | 20.0 | 3.8 | 67.6±3.3 | 22/30 | 2.9 | 5.77±0.32 | 11.7±1.0 | 5.0 | 5.64±0.35 | 12.0±1.1 |

| AK–8 | Aeon–995 | Weldona | 592473 | 4463764 | Probable *Succinea* (single shell) | 3.6 | -4.6 | 10.24±0.06 | 11.95±0.24 | 0.98 |
|---|---|---|---|---|---|---|---|---|---|---|
| H–R–3,4,5,9 | Aeon–1064 | Orchard | 581980 | 4466741 | Probable *Succinea* (four shells from ~15 cm thick bed) | 3.7 | -3.8 | 12.36±0.15 | 14.53±0.56 | 1.00 |
| KC–245 | Aeon–950 | Orchard | 577915 | 4464174 | mostly lignite? | 2.5 | -23.2 | 39.80±3.10 | 43.90±5.69 | 1.00 |

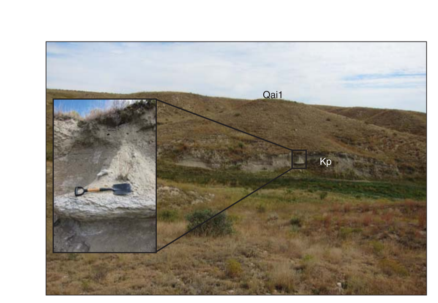
[1]Radiocarbon ($^{14}$C) activity measured by accelerator mass spectrometry (AMS).
[2]UTM zone 13, 1927 North American Datum (NAD 27).
[3]Relative difference between $^{13}$C/$^{12}$C ratio of carbon extracted from subsample and that of Vienna Pee Dee Belemnite (VPDB) international standard.
[4]Conventional radiocarbon age, normalized to -25‰, based on 5,568-year half-life; uncertainty ±1σ.
[5]Calibrated age calculated using CALIB 7.0, IntCal13 dataset (Stuiver and Reimer, 1993; Reimer and others, 2013); 0 yr B.P. = 1950 A.D.; uncertainty ±2σ. Calibrated age reported as midpoint of calibrated range.
[6]Probability of calibrated age falling within reported range as calculated by CALIB.

**Table 3.** *U-Th concentrations, U-series isotope compositions, and calculated $^{230}$Th/U ages and initial $^{234}$U/$^{238}$U activity ratios for subsamples of EF–Wp67 and EIC–Wp95 (taken from Berry and others, 2015b).*

[Abbreviated version of table 1-1 in Paces (2015). Note that ±2σ represents estimates of uncertainty given at the 95 percent confidence level; µg/g, micrograms per gram; σ, sigma; ka, thousand years.]

| Field number | Lab sample name | U concentration, in µg/g | Th concentration, in µg/g | Measured $^{230}$Th/$^{232}$Th AR[1] | Detritus-corrected activity ratios[2]: $^{230}$Th/$^{238}$U AR±2σ | Detritus-corrected activity ratios[2]: $^{234}$U/$^{238}$U AR±2σ | $^{230}$Th/U age ±2σ(ka)[3] | Initial $^{234}$U/$^{238}$U AR±2σ[3] |
|---|---|---|---|---|---|---|---|---|
| EF–Wp67 | Carbonate rind (subsample Wp67–1) and layers of bone (subsamples Wp67–2 through Wp67–11). Location of EF–Wp67: UTM 564654E., 4462502N.[4] | | | | | | | |
| | Wp67–1 | 22.5 | 1.64 | 5.7 | 0.117±0.011 | 1.221±0.004 | 11±1.1 | 1.228±0.004 |
| | Wp67–2 | 83.0 | 0.325 | 104 | 0.1338±0.0012 | 1.214±0.003 | 12.70±0.13 | 1.221±0.003 |
| | Wp67–3 | 107 | 0.044 | 1150 | 0.1520±0.0006 | 1.210±0.003 | 14.58±0.07 | 1.219±0.003 |
| | Wp67–5 | 116 | 0.025 | 2300 | 0.1588±0.0007 | 1.215±0.003 | 15.21±0.08 | 1.224±0.003 |
| | Wp67–7 | 115 | 0.028 | 2020 | 0.1600±0.0007 | 1.221±0.002 | 15.26±0.08 | 1.231±0.003 |
| | Wp67–9 | 116 | 0.032 | 1600 | 0.1458±0.0006 | 1.217±0.003 | 13.87±0.07 | 1.226±0.003 |
| | Wp67–11 | 104 | 0.124 | 322 | 0.1255±0.0006 | 1.217±0.003 | 11.82±0.06 | 1.225±0.003 |
| EIC–Wp95 | Innermost carbonate rinds on alluvial clasts. Location of EIC–Wp95: UTM 567342E., 4458109N.[4] | | | | | | | |
| | Wp95–A1–1 | 5.92 | 0.280 | 66.9 | 1.040±0.008 | 1.125±0.007 | 248±9 | 1.252±0.010 |
| | Wp95–A1–2 | 7.36 | 0.309 | 76.7 | 1.061±0.007 | 1.084±0.003 | 337±15 | 1.217±0.009 |
| | Wp95–A2–1 | 10.2 | 0.274 | 121 | 1.065±0.009 | 1.085±0.003 | 341±20 | 1.222±0.012 |
| | Wp95–A3–1 | 7.12 | 0.549 | 41.3 | 1.048±0.009 | 1.094±0.004 | 294±13 | 1.216±0.008 |
| | Wp95–B1 | 7.90 | 0.901 | 28.2 | 1.057±0.01 | 1.077±0.004 | 345±24 | 1.205±0.012 |
| | Wp95–B2 | 7.60 | 0.509 | 47.6 | 1.048±0.007 | 1.079±0.003 | 324±15 | 1.197±0.008 |
| | Wp95–B3 | 9.58 | 0.672 | 46.3 | 1.069±0.007 | 1.072±0.003 | 397±27 | 1.221±0.014 |
| | Wp95–E1 | 9.91 | 0.461 | 67.7 | 1.037±0.006 | 1.054±0.003 | 372±21 | 1.153±0.008 |

[1]Measured activity ratio (AR) corrected for mass fractionation, spike contributions, procedural blank and normalized relative to an atomic ratio value for National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) 4321B U-isotope standard of $^{234}$U/$^{238}$U=0.0000529.
[2]Ratios corrected for an assumed Th-bearing detrital component having an atomic Th/U of 4 with the following activity ratios and 2σ errors: $^{232}$Th/$^{238}$U=1.276±0.64; $^{234}$U/$^{238}$U=1.0±0.1; and $^{230}$Th/$^{238}$U=1.0±0.25.
[3]$^{230}$Th/U ages, initial $^{234}$U/$^{238}$U activity ratios (ARs), and associated errors are calculated using detritus-corrected activity ratio values.
[4]UTM zone 13, 1927 North American Datum (NAD 27).



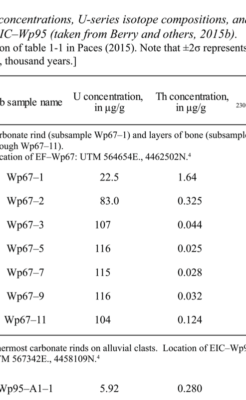

Exposure of weathered upper transition member Pierre Shale (Kp) cropping out in a gully southeast of the Narrows. Qai1 gravels cap surface at skyline. Shovel is 68 cm long. Photographs by M.E. Berry, September 2015.


View to the northwest of young alluvium 3 (Qa3) terrace southeast of the Narrows. The terrace surface in this area is dissected by small gullies, as seen in middle ground. The South Platte River, visible to the left, has overflowed its banks and floodwater is covering the active floodplain. Photograph by M.E. Berry, June 2015.

[1]Ages for time divisions are from Walker, J.D. and others (2012), Walker, M.J.C and others (2012), and Cohen and others (2013; updated). Ma, million years; ka, thousand years.
[2]Subdivisions of Holocene are informal divisions advocated by Walker, M.J.C and others (2012).
[3]Calabrian and Gelasian Ages.

CONVERSION FACTORS

| Multiply | By | To obtain |
|---|---|---|
| millimeter (mm) | 0.03937 | inch (in.) |
| centimeter (cm) | 0.3937 | inch (in.) |
| meter (m) | 3.281 | foot (ft) |
| kilometer (km) | 0.6214 | mile (mi) |




Exposure of weathered upper transition member Pierre Shale (Kp) capped by thin veneer of young alluvium 3 (Qa3) terrace gravels southeast of the Narrows. Shovel is 68 cm long. Photograph by M.E. Berry, June 2015.



For more information concerning this publication, contact
Center Director, USGS Geosciences and Environmental Change Science Center
Box 25046, Mail Stop 980
Denver, CO 80225
(303) 236-5344

Or visit the Geosciences and Environmental Change Science Center Web site at
https://gec.cr.usgs.gov/

ScienceBase citation for the geologic map: Berry, M.E., Taylor, E.M., Slate, J.L., Paces, J.B., Hanson, P.R., and Brandt, T.R., 2018, Data release for the geologic map of the Weldona 7.5′ quadrangle, Morgan County, Colorado: U.S. Geological Survey data release, https://doi.org/10.5066/F7610Z63.

ScienceBase citation for geochronology of the river corridor: Berry, M.E., Hanson, P.R., Paces, J.B., Taylor, E.M., and Slate, J.L., 2018, Data release of OSL, $^{14}$C, and U-series age data supporting geologic mapping along the South Platte River corridor in northeastern Colorado: U.S. Geological Survey data release, https://doi.org/10.5066/F7QN65M3.

Suggested citation: Berry, M.E., Taylor, E.M., Slate, J.L., Paces, J.B., Hanson, P.R., and Brandt, T.R., 2018, Geologic map of the Weldona 7.5′ quadrangle, Morgan County, Colorado: U.S. Geological Survey Scientific Investigations Map 3396, 1 sheet, scale 1:24,000, https://doi.org/10.3133/sim3396.

ISSN 2329-132X (online)
https://doi.org/10.3133/sim3396