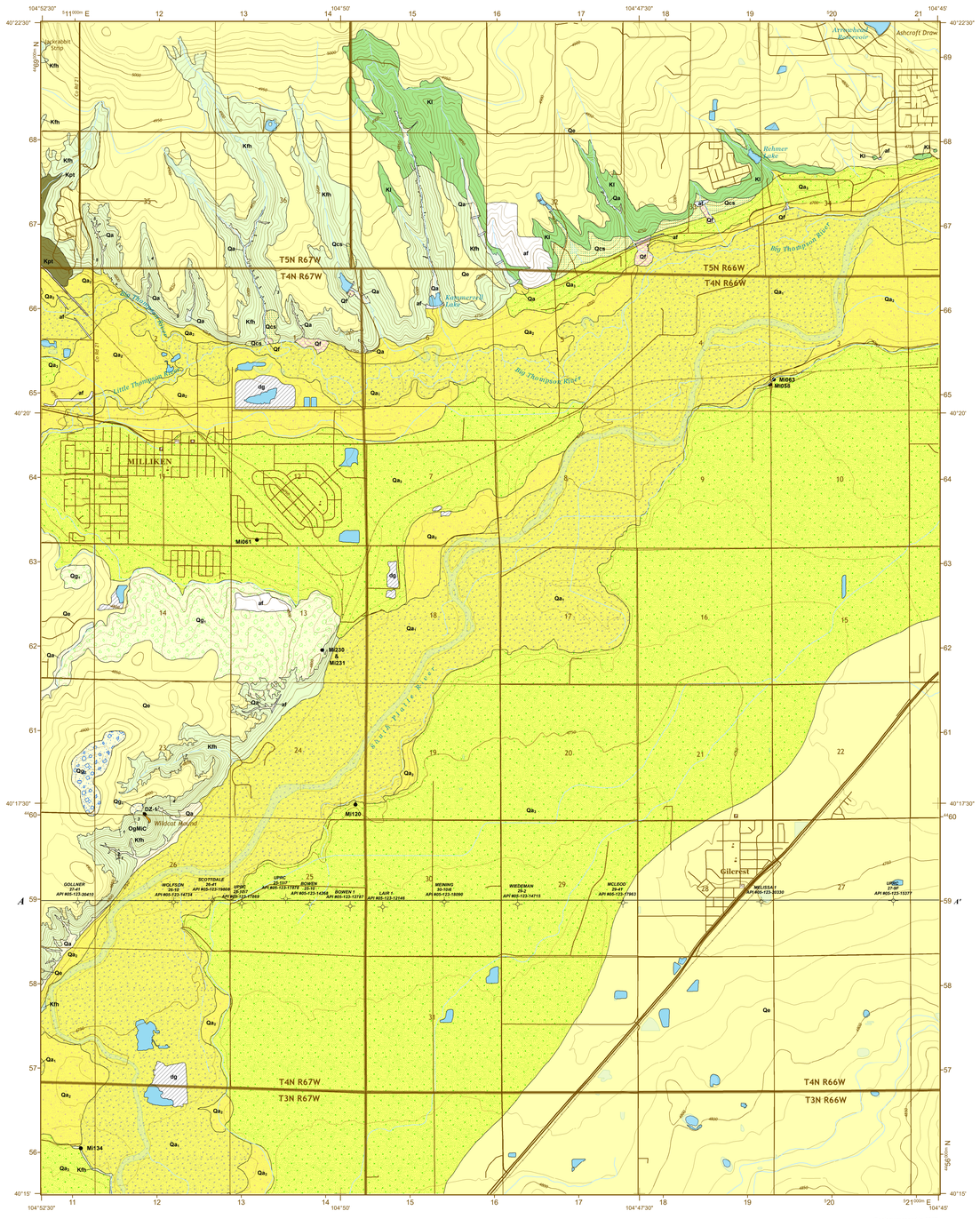

Geology mapped in 2017
GIS and cartography by Pangaea Geospatial

Coordinate System: NAD 1983 UTM Zone 13 North
Projection: Transverse Mercator
Datum: North American 1983

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Roads	U.S. Census Bureau, 2015-2016
Names	GNIS, 2016
Hydrography	National Hydrography Dataset, 2013
Contours	National Elevation Dataset, 1998
Boundaries	Multiple sources; see metadata file, 1972-2016
Public Land Survey System	BLM, 2011

This mapping project was funded jointly by the Colorado Geological Survey and the U.S. Geological Survey through the National Cooperative Geologic Mapping Program under STATEMAP agreement G17AC00259.

GEOLOGIC MAP OF THE MILLIKEN QUADRANGLE, WELD COUNTY, COLORADO

By Martin J. Palkovic, Kassandra O. Lindsey, and Matthew L. Morgan

2018

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

HUMAN-MADE DEPOSITS

af — **Artificial fill (uppermost Holocene)** — Riprap, fill, and refuse placed during construction of roads, railroads, buildings, dams and landfills. Generally consists of clay, silt, sand, and rock fragments. The average thickness of the unit is less than 20 ft (6 m). Artificial fill may be subject to settlement, slumping, and erosion if not adequately compacted. Extensive areas of artificial fill may exist in residential and commercial developments in the Milliken area; however, fill areas are usually less than 5 ft (1.5 m) thick and difficult to delineate, thus the underlying geology was mapped in developed areas.

dg — **Disturbed ground (uppermost Holocene)** — Areas where mining operations have removed much of the original deposit and reclamation of the landscape has not occurred.

ALLUVIAL DEPOSITS

Qa$_1$ — **Alluvium one (upper Holocene)** — Brown sandy silt and silty clay with lenses of coarse sand and pebble gravel. Gravel ranges from subangular to well rounded and dominantly consists of quartzite, vein quartz and granitoids derived from Precambrian igneous and metamorphic rocks exposed in the Front Range. The unit underlies the South Platte River, the Big Thompson River, and underlies low-lying terraces 2-5 ft (0.6-1.5 m) above these streams. St. Vrain Creek is incised to bedrock in the quadrangle; however, Qa$_1$ deposits occur adjacent to the stream channel. Channel-bar deposits exist adjacent to active streams, and are composed of gravelly sand with lenses of fine-grained sediment. Gravel in the channel-bar deposits consists of granitoids, gneiss, quartzite, and vein quartz. On the nearby Berthoud quadrangle (Keller and others, 2017), a sample taken from a depth of 3 ft (1 m) below a ~5 ft (~1.5 m) terrace of the Little Thompson River yielded a 14C age of 905 to 855 cal BP (910 ± 30 14C yr BP) indicating the unit is late Holocene in age. Unit Qa$_1$ may be correlative with the post-Piney Creek Alluvium of Colton (1976) and Units F1 and F4 of Schwochow (1974). This unit was subject to cutting and/or grading and may contain artificial fill in the upper 5 ft (1.5 m). This unit may be subject to occasional flooding and a high water table due to its proximity to modern streams. Unit Qa$_1$ is typically 2-5 ft (0.6-1.5 m) thick.

Qa$_2$ — **Alluvium two (Holocene)** — Gray to brown, weakly stratified, silty to clayey sand with beds and lenses of sandy pebble gravel. Clasts are subrounded to well rounded pebbles of quartzite, vein quartz, and granitoid rocks derived from the Front Range. Unit Qa$_2$ underlies stream terrace deposits that are approximately 5-15 ft (1.5-4.6 m) above the floodplain. Organic-rich material is found in the upper 1-2 ft (0.3-0.6 m) of the unit and stringers of calcium carbonate (Stage I) are common lower in the unit. In the nearby Berthoud quadrangle, Keller and others (2017) reported two radiocarbon ages from unit Qa$_2$; the first sample yielded a 14C age of 1475 to 1465 cal BP (1530 ± 30 14C yr BP), and the second yielded a 14C age of 2430 to 2350 cal BP (2390 ± 30 14C yr BP). Samples Mi058 and Mi063 in unit Qa$_2$ yielded Optically Stimulated Luminescence (OSL) age estimates of 6,130 ± 470 yrs and 3,160 ± 270 yrs, respectively. Unit Qa$_2$ may be correlative with the upper part of the Piney Creek Alluvium (Colton, 1976). Parts of this unit have been cut and graded and may contain artificial fill in the upper 5 ft (1.5 m). This unit may be subject to occasional flooding. Unit Qa$_2$ is a potential source of commercial sand and was actively mined on the quadrangle at the time of this publication. Maximum exposed thickness of the unit locally exceeds 10 ft (3 m).

Qa$_3$ — **Alluvium three (Upper Pleistocene)** — Light-brown to yellowish-brown, poorly sorted, fine to coarse sand with lenses of pebble gravel and lenses of silt to very fine sand. Unit Qa$_3$ underlies terraces approximately 35 to 70 ft (11 to 21 m) above streams. Clasts in unit Qa$_3$ are subrounded to well rounded and are dominantly composed of quartzite, vein quartz and phaneritic, felsic igneous rocks. The matrix predominantly consists of silt and clay. Sample Mi120 in unit Qa$_3$ yielded an OSL age estimate of 13,220 ± 830 yrs. Unit Qa$_3$ may be correlative with the Broadway Alluvium of Colton (1976) and Units T3 and T4 of Schwochow (1974). The unit is a potential source of sand and gravel. A borehole registered with the Colorado Division of Water Resources located in NW¼ SE¼ sec. 7, T. 4 N., R. 66 W., located on a terrace between the South Platte River and the Big Thompson River encountered Fox Hills Sandstone at a depth of 32 ft (9.75 m). Construction excavations located at SW¼ SW¼ sec. 12, T. 4 N., R. 67 W. encountered unit Qa$_3$ to a depth of 5 ft (1.5 m), indicating the unit may be between 5-32 ft (1.5-9.75 m) thick. Deposits of eolian sand less than 5 ft (1.5 m) thick may overlie areas mapped as Qa$_3$ (Madole, 2005); however, they are not mapped separately due to local variations in thickness and disturbance from human activities. Parts of this unit have been excavated and graded and may contain artificial fill in the upper 5 ft (1.5 m), especially in residential areas.

Qa — **Alluvium, undivided (Holocene to Upper Pleistocene)** — Deposited in valley heads and swales in the upper parts of tributary drainages where differentiation of specific alluvial units was not possible due to poor exposure or lack of access. Deposit is generally gray to brown, weakly stratified, moderately consolidated, silty and clayey sand with thin beds and lenses of sandy pebble gravel. The exposed thickness of the unit locally exceeds 5 ft (1.5 m). Unit is subject to occasional flooding.

Qg$_{f1}$ — **Gravel deposit one (Middle Pleistocene)** — Gray to light-brown, poorly sorted, matrix-supported gravel with a silty matrix that mantles pediment surfaces 20-90 ft (6-27 m) above modern streams. Clasts are subrounded to rounded, and dominantly composed of quartzite, vein quartz, and schist. In the Qg$_{f1}$ deposit underlying a terrace between the Big Thompson and the South Platte in T. 4 N., R. 67 W., eolian sediment (unit Qe) may cover and interfinger with Qg$_{f1}$. The soil profile of this unit, exposed in SE¼ sec.13, T. 4 N., R. 67 W., consists of a 6-12 inch (15-30 cm) A horizon underlain by a 4-5 ft (1.2-1.5 m) Bk horizon (Stage II of Machette (1985)). Approximately one third of analyzed clasts contain carbonate rinds. Carbonate accumulation is predominantly on undersides of clasts but also on tops. A 12 inch (15-30.5 cm) thick zones within the Bk horizon. The lack of A (clay-rich) horizon above the Bk suggests that the deposit has either undergone episodes of instability where the B horizons were removed/disturbed or the deposit is not of significant age resulting in the accumulation of clays. Samples Mi230 (4 ft/1.2 m below ground surface) and Mi231 (2 ft/0.6 m below ground surface) in unit Qg$_{f1}$ yielded OSL age estimates of 56,310 ± 3,460 yrs and 24,120 ± 1,760 yrs. ^{232}Th/U ages were also calculated on carbonate rinds of clasts in unit Qg$_{f1}$ (Table 3), yielding ages ranging from 256 to 40 ka. Unit Qg$_{f1}$ may be correlative with the Slocum Alluvium of Colton (1976) and Unit U2 of Schochow (1974). This unit was quarried for aggregate on the quadrangle and is considered a source of sand and gravel. Estimated thickness is 10 to 90 ft (3 to 27 m) (Madole, 1991).

Qg$_{f2}$ — **Gravel deposit two (Middle(?) Pleistocene)** — Gray to light-brown, poorly sorted, matrix-supported gravel with a sandy-silty matrix that is found 100 to 250 ft (30-76 m) above modern streams. Clasts are angular to well rounded, and are dominantly composed of quartzite, vein quartz, granitoids and schist, and approximately one third to one half of surveyed clasts contain carbonate rinds on the undersides of clasts. Eolian sediment may cover and interfinger with Qg$_{f2}$. Unit Qg$_{f2}$ may be correlative with the Verdos Alluvium of Colton (1976). This unit is a potential source of sand and gravel. The thickness of unit Qg$_{f2}$ typically ranges from 10-40 ft (3-12 m).

Qf — **Alluvial-fan deposits (Holocene to Upper Pleistocene)** — Tan to yellowish-brown, poorly sorted, clayey to silty sand and gravel, deposited as individual or coalesced alluvial fans at the mouths of hillside swales and ephemeral streams. Unit Qf has a fan-like shape and may contain reworked well-rounded pebbles derived from local surficial and bedrock deposits. The unit may be prone to flooding and sediment-laden mud floods. The unit is a potential source of sand and gravel. Deposits locally exceed 8 ft (~2m) in thickness.

Qcs — **Colluvium and sheetwash deposits, undivided (Holocene to Upper Pleistocene)** — Colluvium consists of fragments of high-level gravels and bedrock that have been transported downslope primarily by gravity. The deposits are gray to tan to yellowish-brown, poorly sorted, clast-supported, pebble to boulder gravel in a sandy matrix, to matrix-supported, gravelly, clayey, sandy silt. Colluvium contains rounded to subrounded clasts and is weakly stratified. Sheetwash deposits are gray-brown to gray-tan, poorly sorted, silty to sandy clay with scattered gravel-sized rock fragments. Unit thinly mantles (<10 ft/3 m) low relief, moderate slopes where bedrock is shallow and consists chiefly of local materials transported by sheet flow. Unit may include sediments from rills and minor gullies, reworked windblown sediment, and bedrock residuum. Unit is generally 5-10 ft (1.5-3 m) thick but may include zones of bedrock residuum near surface. Colluvium and sheetwash deposits may grade into, and interfinger with, alluviums one, two, and three (Qa$_1$, Qa$_2$, and Qa$_3$) and eolian deposits (Qe). Areas mapped as colluvium and sheetwash are susceptible to future colluvial and sheetwash deposition and locally are subject to small debris flows. These deposits may be sources of aggregate. Maximum thickness of this unit is approximately 15 ft (4.5 m).

EOLIAN DEPOSITS

Qe — **Eolian sediment (middle Holocene and Upper Pleistocene)** — Light-brown to yellowish-brown, windblown, micaceous clayey silt with minimal sand (commonly referred to as "loess"). Sieve analysis of a sample from the adjacent Johnstown quadrangle (Sample #4, Palkovic and Morgan, 2017) contained 0% gravel, 14% sand, and 86% fines (material passing a #200 sieve). Atterberg Limit determinations revealed a liquid limit of 27 and a plastic limit of 22 (plasticity index = 5). According to the Unified Soils Classification System, the soil is a silt with low plasticity (ML). Loess commonly lacks topographic relief and is not associated with any landform (Madole, 2016); however, contacts were discernable on Lidar imagery due to the landforms associated with adjacent alluvial deposits. Late Pleistocene and Holocene alluvial units may contain reworked Qe. Organic-rich sediment within eolian sand overlying unit Qa$_3$ (sample MI061) yielded a 14C age of 4627 to 4432 cal yr BP (4060 ± 30 14C yr BP). OSL analysis on a sample from the adjacent Johnstown quadrangle (Sample #5, Palkovic and Morgan, 2017) yielded an OSL age estimate of 22,150 ± 2720 yrs. Radiocarbon dating in the adjacent Johnstown quadrangle (Sample #4, Palkovic and Morgan, 2017) yielded a 14C age of 9255 to 9055 cal BP (8180 ± 30 14C yr BP). On the basis of these ages, windblown sediment in Johnstown is generally correlative with loess near Beecher Island, CO (Muhs and others, 1999) and Late Pleistocene dune sand of eastern Colorado (Muhs and others, 1996). Parts of this unit have been excavated and graded and may contain artificial fill in the upper 5 ft (1.5 m). Unit Qe has little economic value; however, it is a highly productive agricultural medium in Weld County. Unit Qe may be subject to migration in areas that are not sufficiently vegetated. In the adjacent Berthoud quadrangle (Keller and others, 2017), the unit varies between 8 and 15 ft (2.4 to 4.6 m) thick.

BEDROCK GEOLOGY

OgMlC — **Conglomerate of Wildcat Mound (Miocene? to Oligocene)** — Light-gray to gray, matrix-supported conglomerate with a medium to coarse sand matrix. Bedding ranges from massive to cross stratified and calcareous cement is present throughout. Clast composition consists of granite, granodiorite, quartzite, vein quartz, gneiss and lesser amounts of schist. Clasts are subrounded to well rounded and poorly sorted, ranging in size from 10-100 mm. Clasts occasionally have carbonate rinds on their undersides. Matrix composition dominantly consists of quartz grains with lesser amounts of potassium feldspar, plagioclase feldspar and lithic fragments. The sole exposure of this unit on the quadrangle is at Wildcat Mound (S½ sec. 23 and N½ sec. 26, T. 4 N., R. 67 W.) in the southwest portion of the quadrangle. Uranium-Lead (U-Pb) geochronology of a detrital zircon sample (n=58) at Wildcat Mound indicates the unit has a maximum depositional age of 28 Ma (Fig. 1) (M. Schmitz, Boise State University, written communication, 2017).

Kl — **Laramie Formation (Upper Cretaceous)** — Light-gray to yellowish-gray, well-indurated quartz sandstone interbedded with dark gray, fissile, friable, well-laminated shale and lenticular seams of carbonaceous shale and lignite. Poor exposures exist in the Milliken quadrangle, but the unit was observed on a hillside in NE¼ SW¼ sec. 33, T. 5 N., R. 66 W. and within a pipeline excavation located in NE¼ NE¼ sec. 25, T. 5 N., R. 67 W. The contact with the underlying Fox Hills Sandstone (Kfh) is conformable, and unit Kl may locally interfinger with unit Kfh.

Kfh — **Fox Hills Sandstone (Upper Cretaceous)** — Light-brown to brown, buff, friable, massive, very fine to fine arenitic to subarkosic sandstone to shaly sandstone. Outcrops may be covered in sandy resiuduum. A facies of dark-brown to dark-gray, thinly bedded, highly competent, silica-cemented, fine-grained arenitic sandstone commonly overlies the more friable, massive facies, forming hoodoos and preventing erosion of the more friable facies. Ripple marks and brachiopods are abundant at Wildcat Mound (S½ sec. 23, T. 4 N., R. 67 W.), while abundant and well-preserved *Ophiomorpha* burrows were observed in W½ NW¼ sec. 26, T. 4 N., R. 67 W. The light-brown, massively bedded facies may contain interbedded shales, especially farther east towards the contact with the overlying Laramie Formation (Kl). Outcrop exposures are abundant along the north side of the South Platte River and the north side of the Big Thompson River upstream of their confluence. Well-rounded crystalline gravel clasts commonly litter outcrops of the Fox Hills Sandstone adjacent to the South Platte River. The upper and lower contacts of the Fox Hills Sandstone are gradational and parts of the unit are interpreted to be stacked or "shingled" as the Cretaceous Interior Seaway retreated eastward (Dechesne and others, 2011). The Fox Hills Sandstone may locally interfinger with the Upper Transition Member of the Pierre Shale (Kpt) in sec. 34-35, T. 5 N., R. 67 W. and the Laramie Formation (Kl) near sec. 23-24, T. 4 N., R. 67 W. Historically, the contact between the Upper Transition Member of the Pierre Shale and the Fox Hills Sandstone is arbitrarily defined by Lovering and others (1932) as being 250 ft (76 m) below the base of the Laramie Formation, while Scott and Cobban (1965) note that the contact between the two is unmappable between Denver and Loveland. The unit is approximately 300-500 ft (92-152 m) thick.

Kp — **Pierre Shale (Upper Cretaceous)** — The Pierre Shale is a regionally extensive unit of marine strata found over much of eastern Colorado, and is largely considered to be Campanian to Maastrichtian in age (Scott and Cobban, 1965). The Pierre Shale is primarily composed of dark-gray shale and siltstone, with as many as six sandstone members that are well defined on geophysical logs. The Pierre Shale is underlain by the Smoky Hill Shale Member of the calcareous Niobrara Formation and is overlain by the clastic Fox Hills Sandstone (Scott and Cobban, 1965). Weathered Pierre Shale near the surface may be subject to swelling or heaving. Total thickness is approximately 6,500 ft (1981 m).

Kpt — **Upper Transition Member (Upper Cretaceous)** — Composed of light-brown to brown, friable sandstone to shaly sandstone that is moderately indurated, and well laminated to bedded. The unit is poorly exposed over much of the quadrangle and its extent is limited to a small area in the northwestern part of the quadrangle. The contact is conformable and gradational with the overlying Fox Hills Sandstone, and the unit may interfinger with the Fox Hills Sandstone in sec. 24 T. 4 N., R. 67 W. The unit is approximately 20-380 ft (6-125 m) thick in the mapped area.

Kpu — **Upper Shale (Upper Cretaceous)** — Shown in cross section only. Approximately 3,200 ft (975 m) thick.

Kplr — **Larimer, Richard and Rocky Ridge Sandstone Members and intervening unnamed shale units (Upper Cretaceous)** — Shown in cross section only. Commonly referred to as the Parkman Sandstone member in the subsurface. Approximately 250-360 ft (76-110 m) thick.

Kpm — **Middle Shale Member (Upper Cretaceous)** — Shown in cross section only. Contains the Sussex Sandstone member. Approximately 370-500 ft (113-152 m) thick.

Kph — **Hygiene Sandstone Member (Upper Cretaceous)** — Shown in cross section only. Commonly referred to as the Shannon Sandstone Member in the subsurface. Approximately 390-420 ft (119-128 m) thick.

Kpl — **Lower Shale Member (Upper Cretaceous)** — Shown in cross section only. Approximately 2,100-2,200 ft (640-670 m) thick.

Kn — **Niobrara Formation (Upper Cretaceous)** — Shown in cross section only. Approximately 315-360 ft (96-109 m) thick.

Kcgg — **Colorado Group – Carlile Shale, Greenhorn Limestone, Graneros Shale, and Mowry Shale (undivided) (Upper Cretaceous)** — Shown in cross section only. Approximately 400-450 ft (122-137 m) thick.

MAP SYMBOLS

Contact — Approximately located

Strike and dip of inclined bedding — Showing direction and angle of dip in degrees

Oil and gas well

Numerical age date sample

Alignment of cross section

Fig. 1. Frequency of detrital zircons for sample DZ-1

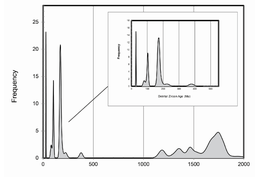

Table 1. Radiocarbon dates.

Field Number	Laboratory Number	Material Dated	UTM Easting[a]	UTM Northing[a]	Latitude	Longitude	Approximate depth (m)	δ^{13}C (‰)	^{14}C age (^{14}C yr BP)[b]	Calibrated age (cal yr BP)[c]
MI061	Beta-477465	Organic Sediment	513168	4463266	40.31982	-104.84501	0.762	-18	4,060 ± 30	4627 - 4432

[a]North American Datum (NAD) 1983, zone 13N

[b]Conventional radiocarbon age, normalized to -25‰, based on 5,568 year half-life; uncertainty ± 1 σ

[c]Calibrated age calculated using INTCAL13 (Reimer et al., 2013); 0 yr B.P. = 1950 A.D.

Table 2. Optically Stimulated Luminescence (OSL) age estimates.

Field Number	Map Unit	Material Dated	UTM Easting[a]	UTM Northing[a]	Latitude	Longitude	Approx depth (m)	% Water content[b]	K (wt. %)[c]	U (ppm)[c]	Th (ppm)[c]	Total Dose (Gy/ka)[d]	Equivalent Dose (Gy)	n[e]	Scatter[f]	OSL age (yrs) ± 1σ[g]
MI058	Qa2	Clay and Silt	519245	4465118	40.33638	-104.7734	2.44	1 (31)	4.50 ± 0.09	1.97 ± 0.18	10.43 ± 0.49	5.61 ± 0.14	34 ± 2.5	18 (18)	30%	6,130 ± 470
MI063	Qa2	Sand	519288	4465179	40.33694	-104.7729	2.44	0 (25)	3.88 ± 0.04	3.23 ± 0.21	17.9 ± 0.30	5.86 ± 0.08	18.5 ± 1.6	19 (20)	28%	3,160 ± 270
MI120	Qa3	Sand and Gravel	514341	4460129	40.29154	-104.8313	1.68	3 (22)	3.61 ± 0.05	1.63 ± 0.22	8.42 ± 0.31	4.63 ± 0.10	61.2 ± 3.6	39 (40)	44%	13,220 ± 830[h]
MI134	Kfh	Sand	511097	4456051	40.25485	-104.8695	3.05	0 (23)	3.90 ± 0.09	3.09 ± 0.28	19.6 ± 0.93	6.01 ± 0.19	327 ± 18	24 (24)	25%	54,410 ± 3,460[i]
MI230	Qg1	Sand and Gravel	513946	4461964	40.30806	-104.8359	1.22	2 (21)	2.56 ± 0.04	1.93 ± 0.19	6.13 ± 0.34	3.66 ± 0.14	206 ± 10	22 (24)	18%	56,310 ± 3,460
MI231	Qg1	Sand and Gravel	513946	4461964	40.30806	-104.8359	0.61	2 (23)	2.32 ± 0.05	2.17 ± 0.24	7.25 ± 0.42	3.57 ± 0.12	86 ± 5.5	26 (30)	32%	24,120 ± 1,760

[a]North American Datum (NAD) 1983, zone 13N

[b]Field moisture, with figures in parentheses indicating the complete sample saturation %. Ages calculated using 25% of the saturated moisture (i.e. 0 (25) = 25 * 0.25 = 6).

[c]Analyses obtained using high-resolution gamma spectrometry (high purity Ge detector).

[d]Includes cosmic doses and attenuation with depth calculated using the methods of Prescott and Hutton (1994). Cosmic doses were about 0.20-0.29 Gy/ka.

[e]Number of replicated equivalent dose (D_E) estimates used to calculate the total. Figures in parentheses indicate total number of measurements included in calculating the represented D_E and age using the central age model (CAM) except Mi120 which used the minimum age model (MAM); analyzed via single aliquot regeneration on quartz grains.

[f]Defined as "over-dispersion" of the D_E values. Obtained by the "R" factor program. Values >30% are considered to be poorly bleached or mixed sediments.

[g]Dose rate and age for fine-grained 250-180 micron sized quartz. Exponential + linear fit used on D_E, errors to one sigma.

[h]Minimum age model reported due to the high scatter value. The central age model is 29,370 ± 2,210 years.

[i]Erroneous age, likely dates resiudum on top of the Fox Hills Sandstone.

Table 3. U-Th concentrations, U-series isotope compositions, calculated ^{230}Th/U ages and initial ^{234}U/^{238}U activity ratios for subsamples of Mi230[a].

Sample Name	U concentration, in µg/g	Th concentration, in µg/g	Measured activity ratios ^{232}Th/^{238}U AR ± 2σ[b]	^{230}Th/^{238}U AR ± 2σ[b]	^{234}U/ ^{238}U AR[b]	^{230}Th/ ^{232}Th AR[b]	^{230}Th/U Age ± 2σ (ka)	Initial ^{234}U/^{238}U AR ± 2σ[c]
Mi230-1	5.977	0.065	0.004 ± 0.00004	0.572 ± 0.004	1.123 ± 0.003	160.144	**76.1 ± 0.831**	**1.153 ± 0.004**
Mi230-2	3.530	0.048	0.005 ± 0.00007	1.045 ± 0.006	1.12 ± 0.009	231.627	**256 ± 11**	**1.25 ± 0.012**
Mi230-3	4.297	0.022	0.002 ± 0.00005	0.492 ± 0.004	1.17 ± 0.005	295.751	**58.4 ± 0.713**	**1.202 ± 0.006**
Mi230-4	7.727	0.028	0.0012 ± 0.00003	0.359 ± 0.003	1.144 ± 0.004	300.976	**40.6 ± 0.447**	**1.163 ± 0.004**
Mi230-5	4.424	0.013	0.0001 ± 0.00003	0.395 ± 0.002	1.177 ± 0.004	398.638	**44.1 ± 0.334**	**1.202 ± 0.004**

[a]See Table 2 for Mi230 location.

[b]Measured activity ratio (AR) corrected for mass fractionation, spike contributions, procedural blank and normalized relative to an atomic ratio value for NIST SRM 4321B U-isotope standard of ^{234}U/^{238}U = 0.0000530

[c]^{230}Th/U ages, initial ^{234}U/^{238}U activity ratios (ARs), and associated errors are calculated using isotope 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.

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