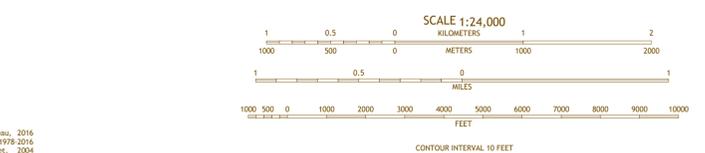


Coordinate System: NAD 1983 UTM Zone 13N
 Projection: Transverse Mercator
 Datum: North American 1983
 This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.
 Initial drafting of this map document was provided by the U.S. Geological Survey. The edited content of this document was neither done by nor endorsed by the USGS.
 Roads: US Census Bureau, 2016
 Names: GNS, 1979-2016
 Hydrography: National Hydrography Dataset, 2004
 Contours: National Elevation Dataset, 2003-2015
 Boundaries: Multiple sources, see metadata file, 2017-2018
 Public Land Survey System: BLM, 2018



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GEOLOGIC MAP OF THE BARNESVILLE QUADRANGLE, WELD COUNTY, COLORADO

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 2021

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Colors are determined using Munsell soil color charts (Munsell Color, 1994). Description of soil-carbonate morphology is after Machette (1985).

ALLUVIUM OF THE SOUTH PLATTE

Qa₁ **Alluvium one (Upper Holocene)** — The unit is mostly moderately to well-sorted, silt to medium sand that is generally very dark grayish-brown (2.5YR 3/2) in color. Three cm-thick gravel lenses are present locally. Sand grains are subangular to round, and grain composition is 80 to 90% quartz with lesser amounts of feldspar and minor (<5%) mica and dark minerals. The unit underlies the South Platte River and low-lying terraces up to 1.5 m above the modern stream channel. A radiocarbon sample collected from Qa₁ along the Little Thompson River in the nearby Berthoud quadrangle yielded an age of 1,530 ± 30 yr BP (Keller and others, 2017; Table 1, Plate 2). The unit is correlative, in part, with unit Qa of Boulder and St. Vrain creeks and alluvium historically mapped as post-Piney Creek Alluvium (Madole, 2016). The unit locally may be as much as 4 m thick. Unit Qa₁ is not a likely source of sand or gravel. Areas underlain by the unit have a 1% annual chance of flooding (Zone A or Zone AE floodway) as mapped by the Federal Emergency Management Agency (FEMA, URL link in references).

Qa₂ **Alluvium two (Middle and Lower Holocene)** — The unit consists mostly of stratified, clast-supported gravel and beds of fine to medium sand. Gravel layers are poorly sorted and dark-brown (7.5 YR 3/2) and brownish-yellow to pale-yellow (10YR 6/6 to 2.5YR 7/4) in color. Sandy layers are poorly to moderately sorted, planar bedded or cross bedded, and pale-yellow to yellow (2.5YR 7/4 to 2.5YR 7/6) in color. Gravel is poorly sorted and poorly stratified. Gravel clasts are typically subangular to subround vein quartz, metamorphic rocks, and sandstone that are as much as 15 cm in diameter. Carbonate rinds are not present on clasts and sand lenses do not effervesce when treated with dilute hydrochloric acid (HCl). Terrace surfaces are approximately 4 m above the modern channel of the South Platte River and the unit is generally 5 m thick. Unit Qa₂ is a likely source of sand or gravel. Areas underlain by the unit have a 1% annual chance of flooding (Zone A or Zone AE floodway) as mapped by the Federal Emergency Management Agency (FEMA, URL link in references).

Two bulk carbon-14 samples were collected from unit Qa₂ along Crow Creek in the adjacent Kersey quadrangle to the west (Lindsey and Palkovic, 2020). The samples yielded age estimates of 1,714 ± 1,565 and 3,929 ± 3,817 cal yr BP (Table 1, Plate 2). Two bulk carbon-14 samples collected from unit Qa₂ along the Little Thompson River in the Berthoud quadrangle yielded age estimates of 30 and 2,930 ± 30 yr BP (Keller and others, 2017; Table 1, Plate 2). The unit is likely correlative with unit Qa₂ mapped in nearby quadrangles along the Front Range and alluvium historically mapped as Piney Creek Alluvium (Hunt, 1954).

Qa₃ **Alluvium three (Upper and Middle Pleistocene)** — The unit consists of poorly sorted gravelly sand and sandy gravel that varies in color: dark-brown (10YR 3/3), very dark-brown (10YR 7/4), yellowish-brown (10YR 5/6), and dark yellowish-brown (10YR 4/6). Gravel clasts are subround to round quartz and granite may reach 4 cm in diameter. Planar bedded or cross bedded sandy layers as much as 1 m thick are present locally. Carbonate rinds <1 mm in thickness are locally present on the bottom of clasts. The unit underlies terrace surfaces approximately 9 m above the modern South Platte River channel. The unit is 6 to 10 m thick. Unit Qa₃ is a source of sand and gravel.

The unit mapped in the Barnesville quadrangle is likely correlative with the units historically mapped as Broadway Alluvium elsewhere in the Colorado Piedmont. The Broadway Alluvium is considered to be about 30 to 12 ka (summarized in Kellogg and others, 2008). Haynes and others (1998) suggest the South Platte River abandoned the terrace underlain by unit Qa₃ (Kersey Terrace) about 11 ka based on archaeological evidence, mammoth and bison bones, and radiocarbon dates estimated from organic sediment samples collected from unit Qa₃ along the Boulder, St. Vrain, and Little Thompson creeks in the Longmont quadrangle yielded age estimates ranging from around 11,000 yr BP to 13,500 yr BP and are likely correlative with the end of the Pinedale Glaciation in Colorado (Schweinsberg and others, 2020; Madole, 2016; Keller and others, 2017; Table 1, Plate 2).

Three samples collected in the adjacent Kersey quadrangle to the west were analyzed by optically stimulated luminescence (OSL) and yielded age estimates of 86,980 ± 4090, 75,540 ± 4020, and 13,510 ± 1375 yr BP (Lindsey and Palkovic, 2020; Table 1, Plate 2). Samples collected on the Gowanda quadrangle were analyzed by OSL and yielded age estimates of 151,360 ± 5,800, >56,305, 54,480 ± 5,540, and 42,285 ± 3,730 yr BP (Keller and others, 2019; Table 1, Plate 2). The oldest sample collected from the Gowanda quadrangle (~151 ka) may be correlative with the end of the Bull Lake Glaciation (Schweinsberg and others, 2020). The ~87 ka and ~75 ka ages from the Kersey quadrangle may be correlative to a period of time when the climate experienced higher runoff prior to the onset of the earliest Pinedale advances (Sharpe and Bright, 2014; Sturchio and others, 1994; Pierce and others, 2011; Dahms, 2004). The remaining ages from Gowanda may be correlative with the earlier stages of the Pinedale glaciation in Colorado (Schweinsberg and others, 1994; Pierce and others, 2011; Dahms, 2004). The ~13 ka sample from the Kersey quadrangle is correlative with the end of the Pinedale Glaciation.

ALLUVIAL AND GRAVEL DEPOSITS, UNDIVIDED

Qa **Alluvium (Holocene)** — The unit is poorly sorted to moderately sorted, silt to coarse sand. The unit is typically dark grayish-brown to brown (10YR 4/2 to 4/3), dark-brown (10YR 3/3), dark yellowish-brown (10YR 5/4 to 4/4), or brown (10YR 5/3). Deposits are un-stratified to moderately stratified. Sand grains are 80-90% quartz, with lesser amounts of potassium feldspar and opaque minerals. Gravel lenses, as much as 3 cm in thickness, are present locally. The unit effervesces slightly to strongly when treated with HCl, depending on the stratigraphic position. The unit underlies the active Crow Creek channel, an ephemeral drainage on the western margin of the mapped area, and beneath terrace surfaces that are as much as 5 m above the modern Crow Creek channel. The modern Crow Creek and associated Holocene units are deposited in a paleovalley (hatched overlay) formed by ancestral drainages. Unit Qa is as much as 5 m thick.

The unit is more easily subdivided into units Qa₁ and Qa₂ in the adjacent Kersey quadrangle to the west of the mapped area; however, eolian sediment overlies most of the older alluvium deposited by Crow Creek within the Barnesville quadrangle. Additionally, farming and other anthropogenic activities have reworked the uppermost meter of most of the Quaternary deposits within the mapped area and thus the alluvium along Crow Creek is mapped as a single unit. Two bulk carbon-14 samples collected from the upper terrace along Crow Creek in the Kersey quadrangle yielded age estimates of 1,714 ± 1,565 and 3,929 ± 3,817 cal yr BP (Lindsey and Palkovic, 2020).

Qa? **Gravel (Pleistocene)** — Shown in cross section only. The unit is inferred from Colorado Division of Water Resources borehole data only. Includes unit interpreted to be Qa₁ locally. Water-well data indicate the unit may be as much as 18 m thick.

EOLIAN DEPOSITS

Qe **Eolian sediment (Holocene to Upper Pleistocene)** — The unit is generally moderately sorted, predominantly medium to coarse sand and light yellowish-brown (10YR 6/4), yellowish-brown (10YR 5/4), or dark yellowish-brown (10YR 3/4, 3/6, 4/4) in color. Silt and fine sand is present locally. Grain composition is >80% quartz, with 10 to 15% potassium feldspar and minor amounts of opaque minerals. Sand grains are subround to round. The unit is non-effervescent to vigorously effervescent when treated with HCl. Eolian sediment within the mapped area is massive, planar bedded, or cross bedded. As much as 5 m of this deposit is exposed in the quadrangle. Colorado Division of Water Resources water-well data indicates the unit is as much as 13 m in thickness within the mapped area.

Eolian sediment is the dominant unit mapped within the quadrangle. The unit is well exposed along Highway 392 in NW 1/4, sec. 17, T. 6 N., R. 63 W. At this location, two eolian deposits of different ages are exposed. Sorting and grain size range from poorly to moderately sorted, fine sand to moderately to well-sorted, medium and coarse sand. The upper 1 m of the sediment exposed along Highway 392 has little to no soil development and mantles a buried soil with an A horizon (~0.5 m), a weakly developed B horizon (~0.5 m), and a weakly developed Bk horizon (extends below exposure). The buried A horizon is visibly darker in color (yellow-brown 10YR 5/4, brown 10YR 4/3, to dark-yellowish brown 10YR 4/4) compared to the other horizons. The buried B horizon has little or no fines and clay films are not present. Calcium carbonate weakly cements the buried Bk horizon and calcium carbonate nodules are weakly developed indicative of Stage I and Stage II soil-carbonate development.

Samples collected from eolian deposits in the region yielded ages that range from Late Pleistocene to Holocene (Madole and others, 2005; Haynes and Haas, 1974). Much of the region's eolian sediment is derived from stream alluvium, which may contribute to the unit's overall coarser sediment fraction in the mapped area (Madole and others, 2005). Parabolic dunes and blowouts are identifiable on hillshaded lidar imagery. Dune crests indicate a prevailing wind direction from the northwest. Dunes dominate the landscape south of Crow Creek and deposits of eolian sediment mantle the majority of the mapped area. Vegetation has stabilized most of the area underlain by eolian sediment within the quadrangle. The unit is a likely source of industrial sand. Areas underlain by unit Qe may be subject to hydrocompaction.

BEDROCK GEOLOGY

Klf **Laramie Formation and Fox Hills Sandstone, undivided (Upper Cretaceous)** — Shown in cross section only. Tan colored sandstone and shale. The Laramie Formation is interbedded with coal seams. Thickness is approximately 90 to 180 m.

Kp **Pierre Shale (Upper Cretaceous)** — Shown in cross section only. Dark-gray shale interbedded with sandstones and cross-cut gypsum veins. The total thickness of the unit is approximately 1800 to 2100 m.

- Kn** **Niobrara Formation (Upper Cretaceous)** — Shown in cross section only. Interbedded layers of chalk, limestone, and shale. Thickness is approximately 60 to 100 m.
- Kcgg** **Colorado Group (Upper Cretaceous)** — Shown in cross section only. The unit includes the Carlile Shale (shale and near-shore sandstone), Graneros Shale (predominantly shale interbedded with sandstone), and Greenhorn Limestone (shale, chalky-shale, and limestone). Thickness is approximately 120 to 140 m thick.

MAP SYMBOLS

- Contact** — Approximately located
- Normal fault** — Existence certain, location concealed; ball and bar on downthrown side (modified from Weimer, 1996)
- Longmont wrench fault zone** — Existence certain, location concealed; ball and bar on downthrown side (modified from Weimer, 1996)
- 23-32 STATE**
- Oil and gas well** (Well name and number shown on map)
- Water well** (Division of Water Resources permit number shown on map)
- Dune crest**
- Eolian blowout**
- Paleovalley**
- A A'** **Alignment of cross section**

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