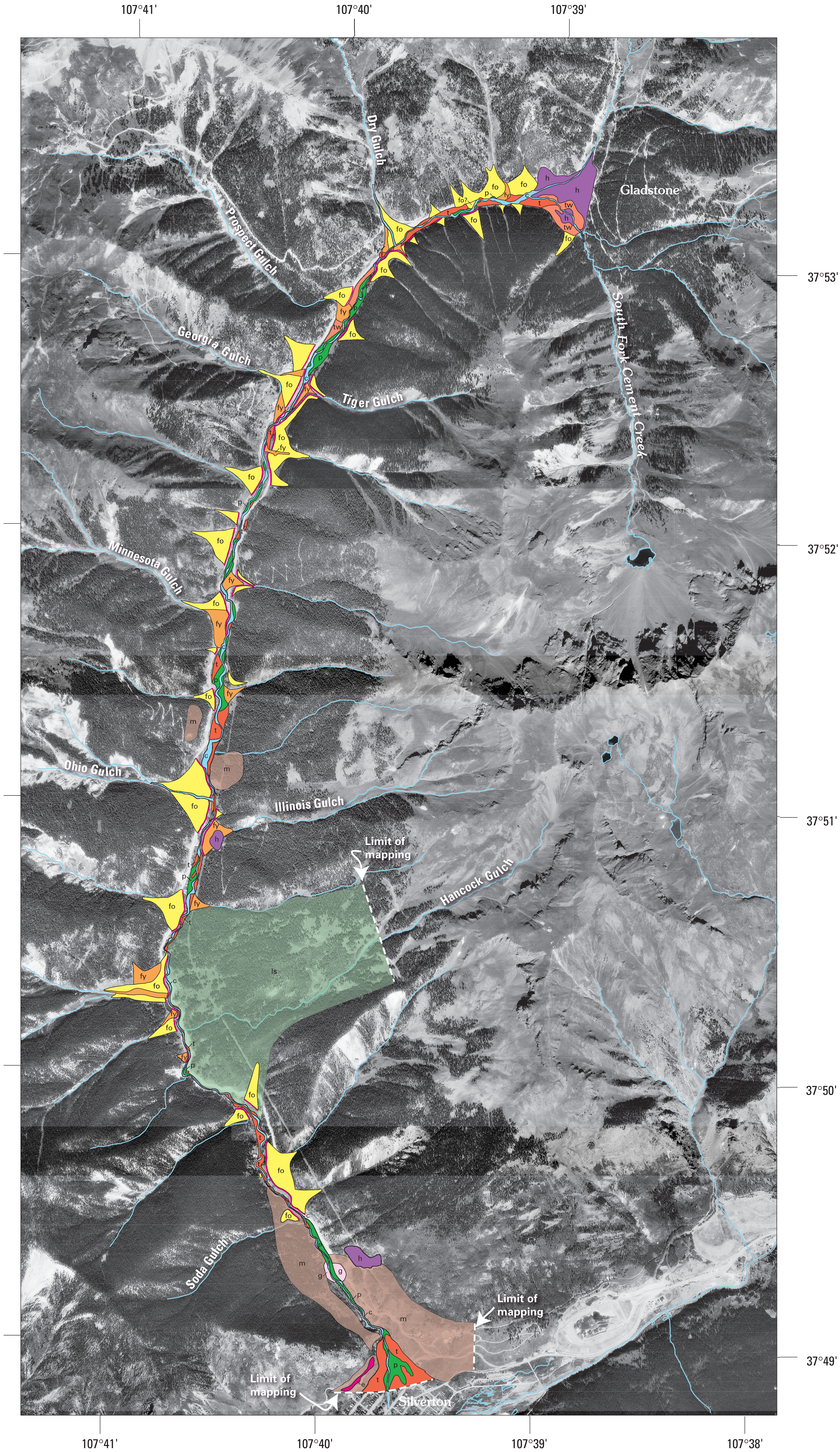


Base from U.S. Geological Survey, Silverton and Ironton DOQ's, 1997

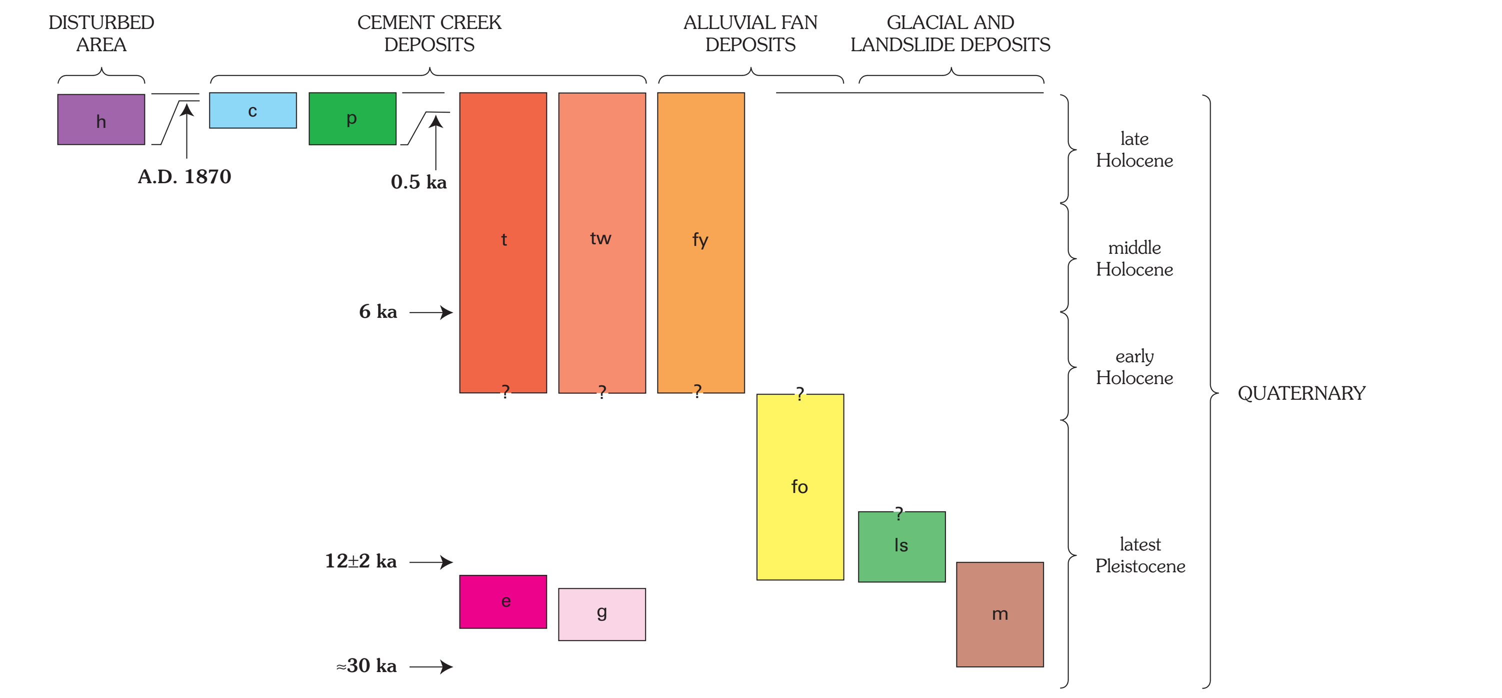
SCALE 1:24 000

1 1/2 0 1 MILE

1 .5 0 1 KILOMETER

Geology mapped by K.R. Vincent

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[This map is a refinement of the Cement Creek portion of the regional work of Blair and others (2002). The principal refinements are subdivision of valley floor deposits and also alluvial fans, and radiocarbon dating. Talus and colluvium deposits were not mapped. All map unit polygons illustrate the spatial extent of a specific deposit, with the exception of alluvial fans. The well-preserved depositional surfaces of fans are delineated by polygons, and erosional escarpments in those deposits are indicated by magenta lines. This was done to illustrate the crosscutting relationships among fan and terrace deposits.

The San Juan Mountains have been extensively glaciated, most recently at the end of the Pleistocene when ice in the Cement Creek valley was about 430 and 520 m thick at Gladstone and Silverton, respectively (Atwood and Mather, 1932). It is therefore unlikely that any of the deposits presented here predate about 30 ka, the approximate onset age of that glacial event, and several deposits apparently formed during deglaciation. The timing of deglaciation is discussed in the text, but it must have been complete prior to 10 ka (Elias and others, 1991) if not earlier. Other age constraints from this study are also discussed in the text.

Many of the clastic deposits are locally cemented (weakly to strongly) with hydrous iron oxides, and these ferricrete deposits appear in cross section as subhorizontal and tabular or irregularly shaped zones]

DISTURBED AREAS

h **Ground disturbed by humans (historical)**—Areas where original landform is obscured because of disturbance by human activities principally related to mining, excluding roads and the railroad, since 1871

CEMENT CREEK DEPOSITS

c **Stream channel deposits (late Holocene)**—The active channel bed and unvegetated gravel bars of Cement Creek and its larger tributaries. Deposits consist of poorly sorted, subrounded pebble- and cobble-supported gravel with sand matrix. Their thickness is unknown but likely less than a few meters. Clasts typically have coatings of, and locally are cemented by, hydrous iron oxides. Channels are typically 5–10 m wide but locally are as much as 40 m wide. At many locations the gravel bars are covered by Lake Emma flood deposits, which consist of pebbles and granules supported in a silt matrix containing sand and clay, and cultural artifacts including mine ventilation pipes. They are also poorly sorted, unstratified, and generally less than a few decimeters thick. The flood occurred on June 4, 1978, when the waters of Lake Emma catastrophically drained underground through mine workings and exited the American tunnel at Gladstone (Bird, 1986). The fact that these deposits have not been reworked by floods in the past 2 decades suggests that Cement Creek is not a particularly dynamic stream

p **Flood-plain or low-terrace deposits (late Holocene)**—Unit underlies the vegetated plain adjacent to and 0.5–1 m higher than the bed of Cement Creek. Deposits generally consist of poorly sorted, subrounded, clast-supported pebble to cobble gravel with a sand matrix. Deposits locally contain peat that underlies sedge wetlands, and hydrous iron oxides of iron bogs. Deposits have observed thickness of as much as 1 m, and they overlie terrace (map unit t) deposits along disconformities. Landforms are typically 5–25 m wide, but locally can reach 60 m wide. Landform is generally absent just downstream of Gladstone, and it may have been remobilized during the 1978 Lake Emma flood. Elsewhere, Lake Emma flood deposits have persisted on gravel bars that are slightly below surface of this landform, suggesting that the "flood plain" is no longer being actively constructed and maintained by Cement Creek. Since that is the definition of a flood plain, this landform may be a low terrace. In any case, the sediment was deposited after A.D. 1500, and the wetland and bog sediment, if not the gravel, continue to accumulate

t **Stream-terrace deposits (Holocene)**—Remnants of a former flood plain of Cement Creek, with surface 1.5–3.5 m higher than the streambed. Terrace is typically 5–25 m wide but locally may reach 70 m wide. Maximum exposed thickness of terrace deposits is 3.5 m. These deposits consist of two facies, one gravel and the other peat, which interfinger as shown in figure 4 (text, Chapter E16). Where the gravel facies is exposed, its surface is dominated by grasses or forest. Where the peat facies is exposed, its surface is dominated by sedge wetlands, including relict and active beaver ponds, or carrs (thickets) of willow and bog birch. Where they occur near each other, the surfaces of gravel sections are generally 0.5–1 m lower than the surfaces of peat sections, as illustrated in figure 4. Where the wetlands were large enough to be mapped separately, they are designated with map unit tw. Gravel facies is poorly sorted, weakly stratified, clast-supported, subrounded pebble or cobble gravel with sand matrix. Locally, gravel contains thin or medium (3–30 cm) beds of sand and sand lenses. Peat facies consists of subhorizontally stratified, thin to thick (3–100 cm) beds of peat. Locally, peat contains very thin or thin (1–10 cm) beds of white silt, which locally grade laterally into channel sands and gravels (fig. 4). The terrace deposits represent channel and flood-plain sedimentation and reworking that began by 6 ka (if not earlier), and rapid aggradation that occurred between 1.5 and 0.5 ka. Thus, the bulk of the exposed deposits are late Holocene in age, although the depositional age of the oldest terrace deposits is not known with respect to the Holocene-Pleistocene boundary. Although channel aggradation ceased 300–500 years ago when Cement Creek incised, the wetland peats continue to aggrade. Peat continues to accumulate because springs draining hillslopes or tributary fans are the sources of water for the wetlands, rather than Cement Creek

tw **Terrace wetland deposits (Holocene)**—A subdivision of the Cement Creek terrace (map unit t) where sedge wetlands are large enough to be mapped separately. See description of map unit t above

e **High stream-terrace deposits (latest Pleistocene)**—A single terrace remnant about 20 m higher than valley floor and inset into a glacial moraine on hillslope on northwest side of town of Silverton. Deposit consists of well-rounded, clast-supported cobble gravel with a sand matrix. Clasts are well rounded. Deposit has unknown stratification and thickness but is likely less than several meters thick. Terrace surface is close to and is inclined away from the mouth of Cement Creek (fig. 2 in text) and thus was likely formed by Cement Creek. Terrace surface projects to base of section of canyon-filling stream gravels (map unit g) in Cement Creek canyon (fig. 2). We conclude that the terrace was formed by Cement Creek at the end of the last glaciation when, evidently, the stream was flowing along the margin of ice that foundered in the Silverton basin (Bakers Park)

g **Canyon-filling stream gravels (latest Pleistocene)**—Nearly vertical cliffs of gravel on both sides of the canyon 500–800 m upstream of mouth of Cement Creek. Deposits are poorly sorted, weakly stratified, clast-supported, subrounded cobble gravel with sand matrix. Gravels are weakly imbricated and stratification dips about 1° down Cement Creek. Clastic sediments are strongly cemented by hydrous iron oxides and are 16 m thick. They rest upon a carved-bedrock platform that also slopes downstream (fig. 2). Charcoal in spring deposits stratigraphically above these gravels has an age of 4.5 ka, which is thus a minimum age for the gravels. Top of section (fig. 2) is higher than projected surface of high stream terrace (map unit e). Since Cement Creek is inferred to have been flowing at the level of the high stream terrace (map unit e) during the final stages of deglaciation, the canyon-filling gravels were deposited shortly before that. The bedrock canyon itself may have been carved by streams prior to the last glaciation

ALLUVIAL FAN DEPOSITS

fy **Young alluvial fan deposits (Holocene)**—Alluvial fan deposits that emanate from the mouths of gulches that are tributary to Cement Creek, and that are typically inset into older fan deposits. Young fan deposits consist of poorly sorted, subangular to subrounded pebble to cobble gravel (with few boulders) that are weakly stratified and clast supported with a sand matrix, or are nonstratified and partly supported by a matrix of sand, silt, and some clay. Maximum exposed thickness is 2 m. Surfaces of distal parts of these fans either merge smoothly with the Cement Creek terrace or are truncated by erosional escarpments. Water flows and debris flows on these fans occasionally require maintenance of roads. These fans are active. They began to form when tributary streams incised their fans (map unit fo) in response to partial breaching of the fan toes by Cement Creek. That breaching by Cement Creek occurred prior to 6 ka, but the timing with respect to the Holocene-Pleistocene boundary is not known

fo **Old alluvial fan deposits (Holocene (?) and latest Pleistocene)**—Incised alluvial fan deposits that emanate from the mouths of gulches that are tributary to Cement Creek. Deposits consist of poorly sorted, subangular to subrounded pebble to boulder gravels that are weakly stratified and clast supported with a sand matrix, or are nonstratified and partially supported by a matrix of sand, silt, and some clay. Maximum exposed thickness is 6 m. At and above Dry Gulch, the distal edges of fans smoothly merge with the Cement Creek terrace (map unit t). Downstream of Dry Gulch, however, Cement Creek has truncated the distal edges of all fans, forming erosional escarpments, and the fan surfaces project as much as 4 m higher than the Cement Creek terrace. One stream bank exposure reveals a buried disconformity that truncates fan deposits and is overlain by terrace deposits. These fans thus became inactive before the terrace formed, and the terrace deposits began to accumulate before 6 ka. It is plausible that the bulk of the fan deposits accumulated shortly after the withdrawal of glacial ice, and before vegetation became established on and thus stabilized hillslopes. Thus, the bulk of the deposits are likely latest Pleistocene in age, but the fan deposits have not been dated directly and deposition could have extended into the Holocene

GLACIAL AND LANDSLIDE DEPOSITS

ls **Landslide deposits (Holocene (?) and latest Pleistocene)**—Landslide deposit on a hillslope adjacent to Cement Creek. Deposit consists of angular, poorly sorted clasts of variable size and matrix composition. Deposit has unknown thickness, but may be tens of meters thick. There is no documented evidence that the landslide is active at present. It is plausible that the landslide formed shortly after the withdrawal of glacial ice, and it is cut by an old alluvial fan (map unit fo), but the slide has not been dated and thus could have come to rest in the Holocene

m **Glacial deposits (latest Pleistocene)**—Glacial till on hillslopes adjacent to Cement Creek and the town of Silverton. Deposits consist of very poorly sorted, compact pebble to boulder gravel in a clayey sand to sand matrix. Their thickness is unknown, but locally could be tens of meters thick. The till was deposited principally as lateral moraines during the last glaciation. The San Juan Mountains were ice free by 10 ka (Elias and others, 1991) if not earlier

Contact or boundary of map unit

Erosional escarpment in alluvial fan deposits

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SURFICIAL GEOLOGIC DEPOSITS ALONG CEMENT CREEK, UPSTREAM OF SILVERTON, COLORADO

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