OPEN FILE MAP 99-05
GEOLOGIC MAP OF THE HUNTER MESA QUADRANGLE
GARFIELD COUNTY, COLORADO
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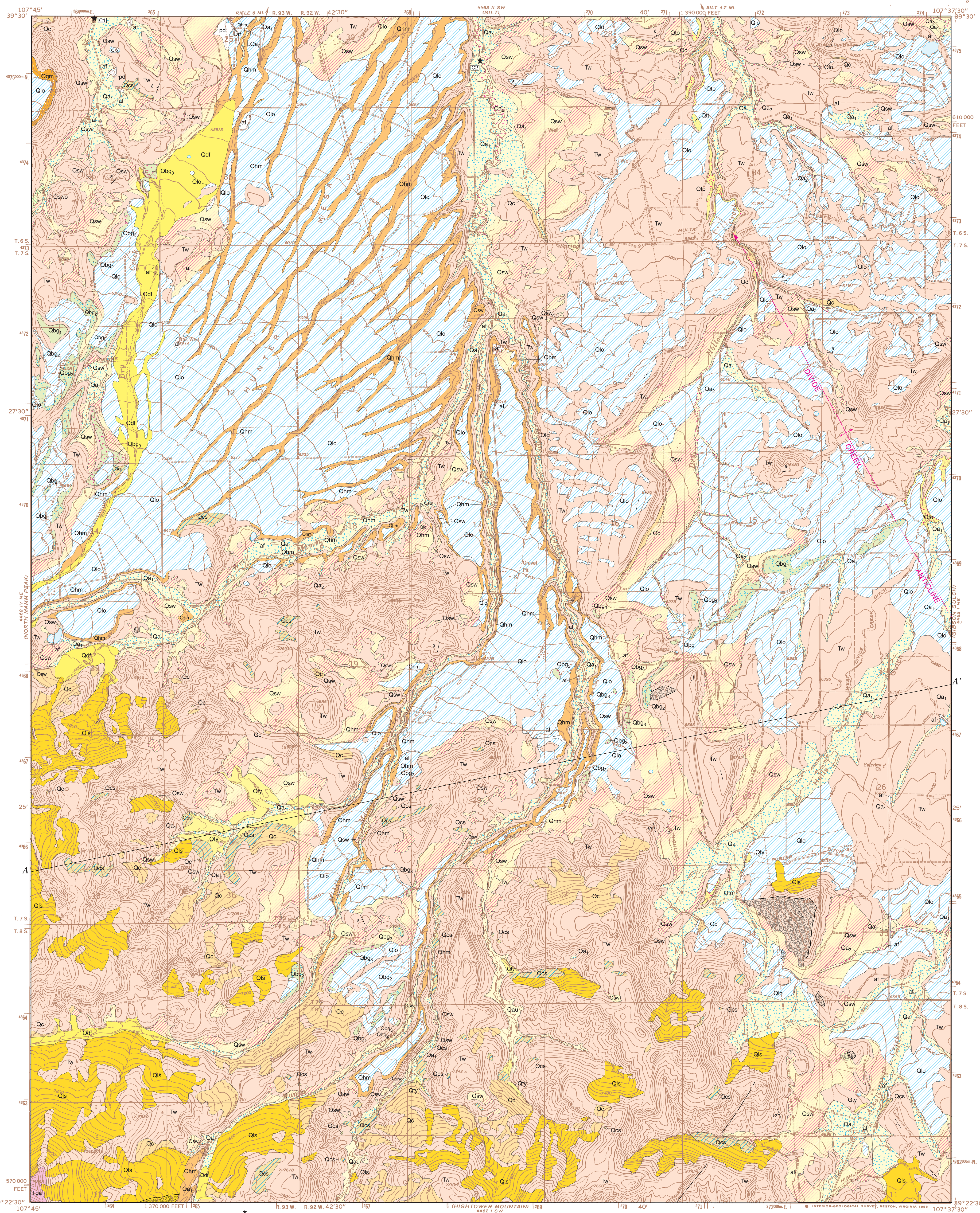
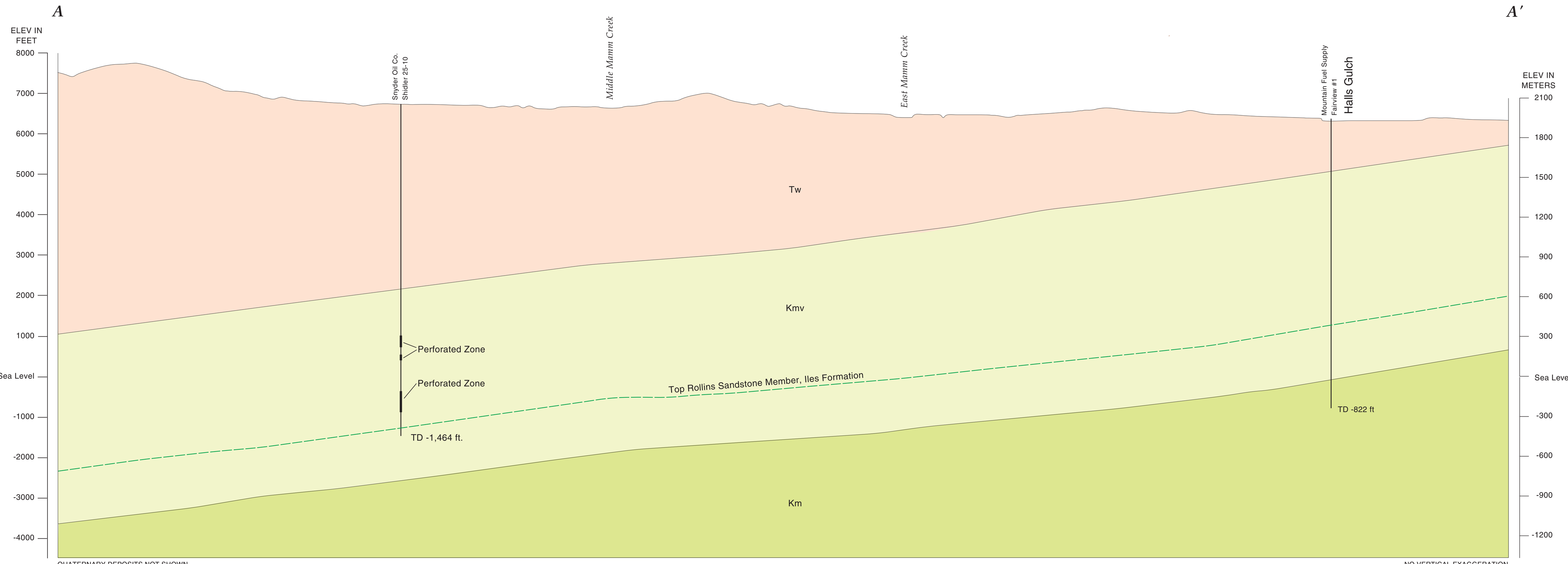




CONDENSED DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

The unit names and symbols used on this map conform as much as possible to those employed previously on geologic maps of nearby areas prepared by the Colorado Geological Survey and U.S. Geological Survey (Fig. 1). The deposits shown on the map were delineated mainly by airphoto interpretation that was verified and supplemented with data collected along traverses on the ground and during intensive field work in selected areas. Airphoto interpretation relied heavily on relations between landforms, material, and geologic process (genesis), as well as between vegetation and geology. Surficial deposits are grouped according to genesis, and individual units within groups are named after the landform with which they are associated or the material of which they are composed.

The cultural features of the topographic base map were photorevised in 1987, and the aerial photography used for geologic mapping was flown in late September and early October 1978. Consequently, roads, reservoirs, and buildings that were constructed after 1987 are not shown on the map, and human-made deposits that postdate the aerial photography may not be on the map. The scale of the base map and aerial photographs (about 1:24,000) governed the minimum size of the deposits shown. With a few exceptions, deposits that have a width or minimum dimension of less than 150 ft or a maximum thickness of less than 5 ft were not mapped.

Most map units are not well exposed. Therefore, the thickness of most units is estimated, and observations of their texture, sedimentary structure (stratification), and composition were limited to a small number of localities. Texture refers to the characteristics of particles—such as size, sorting (a measure of the range in particle sizes present), shape, and roundness—and the grain-to-grain relations among them (Krumbein and Sloss, 1963). Particle size is expressed here in terms of the modified Wentworth scale (Ingram, 1989), and the terms used to describe sorting are those of Folk and Ward (1957). Unit colors for which hue, chroma, and value are listed were determined using Munsell Soil Color charts (Munsell Color, 1973) and are for dry material only. The terms used to describe stratification are from Ingram (1954) who defines very thin bedded as 1–3 cm thick, thin bedded as 3–10 cm, medium bedded as 10–30 cm, thick bedded as 30–100 cm, and very thick bedded as greater than 100 cm.

Except for windblown deposits, all surficial deposits in the map area are poorly sorted to extremely poorly sorted. Particle shape (sphericity) and roundness are also similar in most deposits. Spherical and well-rounded particles are uncommon, and the roundness of most clasts ranges from angular to subrounded. As used here, clast refers to rock fragments larger than 2 mm, and matrix refers to grains that are 2 mm or less in size. Gravel is defined as rock fragments that are more or less rounded and larger than 2 mm in diameter. In the modified Wentworth scale, gravel includes pebbles, cobbles, and boulders, and matrix comprises the sand-, silt-, and clay-size fractions. By definition, pebbles and cobbles are rounded. Therefore, platy or angular to subangular clasts that range in size from 2 mm to 10 cm are referred to as pebble-size or cobble-size.

As used here, the age limits of lower, middle, and upper Pleistocene deposits are about 1800–788 ka, about 788–130 ka, and about 130–10 ka, respectively. These limits correspond approximately to those discussed by Richmond and Fullerton (1986) and Morrison (1991). Although 1800 ka is the date currently accepted for the Pliocene-Pleistocene boundary, many geologists prefer a date of 2600 ka for the beginning of the Pleistocene (Morrison, 1991; Partridge, 1997; Shackleton, 1997; and Suc and others, 1997).

HUMAN-MADE DEPOSITS—Earth materials emplaced or modified by human beings or deposited as a consequence of human activities.

af — **Artificial fill (upper Holocene)**—Sand, silt, clay, and rock debris in earthen dams, highway embankments, dikes for irrigation canals, and spoil from pit silos, ponds, and gravel pits. Unit is 5–60 ft thick.

pd — **Pond deposits (upper Holocene)**—Sand, silt, and clay impounded by earthen dams near the northwest corner of the map area. Similar deposits exist in many places, but most are too small to show at the scale of this map. Unit is estimated to be 1 – 10 ft thick.

ALLUVIAL DEPOSITS—Clay, silt, sand, and gravel transported and deposited by flowing water either in stream channels or as unconfined runoff or sheet flow. Deposits resulting from sheet flow are referred to here as sheetwash. Alluvium deposited by streams is differentiated, where map scale permits, from that deposited mainly by sheet flow. Stream alluvium is the principal deposit underlying flood plains and stream terraces. Sheetwash is present in sheets, wedges, and fans along valley sides. Deposits in which gravel is an important constituent are referred to as either clast-supported or matrix-supported. In a clast-supported gravel, clasts are the dominant constituent and are mostly in point contact. In a matrix-supported gravel, material smaller than 2 mm (sand, silt, and clay) is the dominant constituent and most clasts are not in point contact, but rather are surrounded by matrix and, thus, appear to be embedded in or supported by matrix.

Qa_2 — **Young alluvial fill (upper Holocene)**—Unit underlies channels, narrow flood plains, and remnants of low terraces on arroyo floors. The arroyos are deeply incised (typically 20–40 ft) into unit Qa_1. The time of channel incision has not been documented in the map area. However, it probably correlates with an interval of arroyo cutting, discussed in numerous studies (for example, Bryan, 1925; Graf, 1987; McFadden and McAuliff, 1997), that occurred across much of the southwestern United States in the late 19th century. A radiocarbon age of 320 ± 60 yr B.P. (Table 1) of charcoal from 10 ft below the surface of unit Qa_1 along Mamm Creek in sec. 29, T. 6 S., R. 92 W. provides a maximum age limit for the time of channel incision and subsequent deposition of unit Qa_2. Although unit Qa_2 is present along the axes of most valleys, it is usually wide enough to show at the scale of this map only in the lower reaches of the larger valleys. The unit consists mostly of beds of very pale brown (10YR 7/3, 7/4), poorly sorted silty sand, sand, sandy silt, and minor amounts of clast-supported pebble gravel. Clayey sediment (defined as containing more than 20 percent clay; Shepard, 1954) is present but minor compared to sandy and silty sediment. Beds of matrix-supported gravel emplaced by debris flows also are present in the upper reaches of West, Middle, and East Mamm Creeks. The exposed thickness of unit Qa_2 is generally 3–10 ft.

Qa_1 — **Middle alluvial fill (Holocene and upper Pleistocene?)**—Unit consists of stream-deposited sand, silt, gravel, and minor clay underlying the floors of the larger valleys, which are mainly second-, third-, and fourth-order streams. Because of channel incision, unit Qa_1 is, in effect, a terrace deposit. Commonly, unit Qa_1 supports relatively dense stands of big sagebrush (*Artemisia tridentata*), which indicates that the surface of this unit is rarely, if ever, flooded, given that this shrub will not thrive where overbank flooding is frequent (Jonathan M. Friedman, Biological Resources Division, U.S. Geological Survey, personal commun., 1998). Where valleys are narrow and flanked by high walls, unit Qa_1 includes small deposits of sheetwash and fan alluvium that are too small to show separately at the scale of this map. Most of unit Qa_1 consists of very pale brown (10YR 7/3, 7/4) thin-bedded to very thick-bedded, poorly sorted silty sand, sand, sandy silt, and some beds and lenses (channel deposits) of clast-supported gravel. Beds of matrix-supported gravel emplaced by debris flows or floods that had high sediment concentrations also are present in places along the mainstem of Mamm Creek and its three tributaries, West, Middle, and East Mamm Creeks. The clasts and matrix of these gravels were derived chiefly from the Green River Formation, and to a lesser degree from sandstones of the Wasatch Formation. Most, if not all, of the unit is of Holocene age. In the incised valley of lower Dry Creek in the northwest corner of the map area, 10–12 ft of unit Qa_1 unconformably overlie reddish-brown alluvium that may be of late Pleistocene age. A radiocarbon assay of charcoal from the bottom 1–2 in. of unit Qa_1 in sec. 26, T. 6 S., R. 93 W. yielded an age of 1,380 ± 50 yr B.P. (Table 1). In places, unit Qa_1 is subject to shrink and swell upon drying and wetting, and in the vicinity of deeply incised channels, it is subject to severe piping and subsequent collapse of the ground surface. Unit is generally between 10 and 40 ft thick.

Qsw — **Sheetwash (Holocene and upper Pleistocene)**—Unit consists mainly of very pale-brown, pale-brown, brown, light-yellowish-brown, and light-brown (10YR 7/3, 7/4, 6/3, 6/4, 6/5; 7.5YR 6/4) poorly sorted to extremely poorly sorted silty sand, fine sandy silt, clayey silt and sand, and minor amounts of pebble- and cobble-size rock fragments. The sediment of this unit was transported and deposited principally by sheet flow. Most rock fragments are sandstone and were derived from the Wasatch Formation. Sheetwash is abundant and widespread in the map area owing to a combination of 1) a high percentage of bare ground, 2) large areas of easily eroded bedrock (Wasatch Formation), and 3) runoff from frequent thunderstorms and snowmelt. The unit is particularly extensive along the footslopes of valley sides and escarpments and also is present in topographic depressions on slopes. Unit Qsw was mapped only where it is thick enough to produce the landform that is characteristic of sheetwash, namely a relatively smooth, planar surface that typically slopes toward the axis of the nearest valley or gully and is commonly concave upward. In places, Qsw grades upslope into Qcs or Qc. Unit Qsw locally includes Qa_2 and Qa_3 where the fluvial deposits are too small to show separately. In places, it also includes reworked as well as unmapped eolian sediment. In the vicinity of incised channels, the unit is subject to severe piping and subsequent collapse of the ground surface. Unit is 3–40 ft thick.

Qswo — **Older Sheetwash (Holocene? and upper Pleistocene)**—This unit is similar to Qsw, but is separated from Qsw and the valley floor by escarpments comparable in height to those of unit Qty. The unit is shown only in sec. 35, T. 6 S., R. 93 W. in the northwestern part of the map area. Estimated thickness is 3–30 ft.

Qau — **Alluvium, undivided (Holocene and upper Pleistocene)**—This unit is shown only in narrow, deep, steep-sided reaches of valleys where valley-floor and valley-side deposits are abundant but too small to show individually at the scale of this map. The unit comprises deposits of units Qa_3, Qa_2, Qsw, Qswo, Qcs, and fan alluvium, undivided. Thickness is 3–40 ft.

Qty — **Younger terrace deposits (upper Pleistocene)**—Unit consists of alluvium that underlies remnants of stream terraces that are 30–50 ft above stream level in the upper part of the Mamm Creek drainage basin and upper reaches of Alkali Creek and Halls Gulch. The unit consists mainly of stratified, very poorly sorted sand and silty sand and minor amounts of mostly matrix-supported gravel. Except for cobbles and boulders of basaltic rock along Alkali Creek, clasts are composed almost entirely of sandstone derived from the Wasatch Formation. Estimated thickness is 20–40 ft.

Qto — **Older terrace deposits (middle Pleistocene)**—Unit consists of very poorly sorted boulder to pebble gravel underlying terrace remnants that are 100–120 ft above Dry Hollow Creek (northeastern part of the map area) and Halls Gulch (east-central part of area). Owing to a lack of exposures, not much is known about the physical properties of these deposits, except that they contain abundant clasts of basaltic rock and sandstone. The sandstone clasts came from the Watsatch Formation and the basaltic rock probably was derived from older alluvial and colluvial deposits in the upper part of the respective drainage basins. Unit thickness is estimated to be as much as 50 ft.

Qtt — **Oldest terrace deposits (middle Pleistocene)**—Unit consists of a small deposit of gravel that caps a knoll on the upland west of Dry Hollow Creek in sec. 34, T. 6 S., R. 92 W. (northeastern part of map area). Little is known about the properties of the oldest terrace deposit because much of it is mantled by loess and no exposures were found in areas that are not mantled. Boulders of basaltic rock similar to those in unit Qto, which is at a lower level (40 –60 ft) just north of the knoll, are present on the surface of the oldest terrace deposit. Unit is estimated to be 15–30 ft thick.

MASS-WASTING DEPOSITS—Earth materials that were transported downslope primarily by gravity and not within or under another medium, such as water or ice. Although creep (slow, gradual, progressive downslope movement of earth materials) is a form of mass wasting, material transported by creep is not mapped as a separate unit. Creep exists to some degree on all slopes, but it is slow and its contribution to the transport of various surficial deposits usually cannot be discerned in the field.

Qc — **Colluvium (Holocene to middle Pleistocene)**—Unit comprises slope deposits that consist of pale-brown, light-brown, and light-yellowish-brown to reddish-brown, very poorly sorted to extremely poorly sorted sand, silt, clay, and variable amounts of pebble- to boulder-size clasts. Unit is mainly on or near slopes that are steeper than 25 percent (14°). As used here, colluvium excludes deposits derived by sheet flow. Deposits derived by a combination of mass movement and sheet flow are mapped as Qcs. Most deposits of colluvium are in the higher, more rugged southern part of the map area, where they are particularly extensive on north-facing slopes. The unit probably includes old landslide deposits that have been modified by erosion to the extent that their slope-failure origin is difficult to recognize. In the absence of distinct landslide morphology—such as headwall scarps, hummocky topography, and constricted or obstructed reaches on valley floors—slope deposits are mapped as colluvium. Unit is typically 2–10 ft thick, but may be as much as 30 ft thick in places.

Qls — **Landslide deposits (Holocene and upper Pleistocene)**—Unit consists of an unsorted, heterogeneous mixture of surficial material and fragmented rock debris in a wide range of sizes. The size and kind of clasts and the texture of the matrix vary according to the bedrock units involved in the slide. Sandstone beds of the Wasatch Formation produce larger more durable clasts in landslide deposits than do claystones and siltstones. The unit includes areas of bedrock exposed in slide paths and scarps at the heads of slides as well as the material deposited in the lower part of the slide area. Most slope failures appear to have been relatively shallow. Few deposits retain distinct landslide morphology, which may be a function of their antiquity or their composition. Landslide deposits that contain abundant coarse blocks of durable rock tend to have a more pronounced topographic expression and to retain that topography longer than those composed of fine-grained, weakly indurated rock, such as the claystones and siltsones of the Wasatch Formation. Most landslide deposits are on north-facing slopes of the more rugged terrain in the southern part of the map area. Unit Qls includes deposits of more than one age. Unit thickness is estimated to be 3–50 ft.

Qdf — **Debris-flow deposits (Holocene and upper Pleistocene?)**—Unit consists mainly of white to light-gray (10YR 8/2, 7/2), extremely poorly sorted clast- and matrix-supported gravel. Except for a few debris flows that orinated in small valleys on the Wasatch Formation, clasts and matrix were derived almost entirely from the Green River Formation. Clasts range in size from pebbles to small boulders and are mostly angular to subrounded. Unlike unit Qhm, which was derived from the same area as most of unit Qdf, large basaltic boulders are not present in Qdf within the map area and smaller clasts of basaltic rock are uncommon. Debris-flow deposits overlie unit Qlo in the northwestern part of the map area. Unit is estimated to be as much as 20–25 ft thick.

ALLUVIAL AND COLLUVIAL DEPOSITS—Deposits of both alluvial and colluvial origin that are mapped as a single unit because they 1) are interbedded or 2) exist side by side but are too small to show individually or have boundaries that are difficult to discern.

Qcs — **Colluvium and sheetwash, undivided (Holocene to middle Pleistocene)**—Unit consists of pale-brown, light-brown, and light-yellowish-brown to reddish-brown, extremely poorly sorted sand, silt, and clay and subordinate amounts of pebble- to boulder-size rock debris that were transported and deposited by the combined effects of sheet flow and mass movement. Colluvium is generally subordinate to alluvium except in areas where nearby slopes are steeper than 25 percent (14°). In places, the unit includes unmapped eolian sediment. Unit is estimated to be 3–30 ft thick.

Qhm — **Gravel of Hunter Mesa (middle Pleistocene)**—Unit consists mainly of white to light-gray (10YR 8/2, 7/2) extremely poorly sorted, thin to very thick beds of calcareous clast-supported and matrix-supported gravel interbedded with clayey silt and silty and clayey sand. The unit underlies the gently sloping surface of Hunter Mesa and terraces that flank the valleys of East, West, and Middle Mamm Creeks. Basaltic boulders, a small percentage of which are as large as 5 ft, are common on the surface of the unit. Similar large boulders were not observed within the unit in any exposures. However, deep, extensive exposures exist at only three localities in the map area. Clasts of basaltic rock ranging in size from pebbles to small boulders are abundant in beds of coarse gravel within the deposit. Also, white to light-gray, pebble- and small cobble-sized platy fragments of marlstone and oil shale derived from the Green River Formation are abundant on the surface and are dominant constituents in many beds within the unit. In addition, subrounded sandstone clasts from both the Green River and Wasatch Formations are present in unit Qhm. The color of the matrix and the unit as a whole was inherited mainly from the Green River Formation. Unit Qhm is the most voluminous surficial deposit in the map area, but, in most places, it is mantled by eolian sediment (Qlo). Furthermore, in shallow valleys cut in Qhm, such as those that dissect Hunter Mesa, the unit is partly concealed by thin, narrow deposits of alluvium. Because of their small size these alluvial deposits are not shown on the map. The basal contact of unit Qhm has at least 90 ft of relief. Apparently, the unit filled pre-existing valleys in the Hunter Mesa area and coalesced across adjoining interfluves to form a large fan-shaped deposit. Along Middle Mamm Creek, just upstream from its confluence with East Mamm Creek, the unit ranges in thickness from 40 to 70 ft within a horizontal distance of about 125 ft. Debris-flow and fluvial deposits are both major constituents of Qhm. The unit is at least 85–90 ft thick in places.

Qbg_3 — **Young basaltic boulder gravel (middle Pleistocene)**—Unit consists of extremely poorly sorted boulder to pebble gravel composed predominantly of basaltic rock that caps ridges and knolls that typically rise 40–60 ft, but locally as much as 80 ft, above the upper surface of unit Qhm. Unit Qbg_3 is differentiated from units Qbg_2 and Qbg_1 on the basis of its position in the landscape, mainly height above the upper surface of unit Qhm. Differentiation of this unit on the basis of height above stream level is not practical because many deposits are unrelated to existing drainage systems. Deposits of basaltic boulder gravel mark the courses of paleochannels, now dissected and inverted in the landscape.Topographic inversion occurred because the bouldery channel deposits were more resistant to erosion than the adjacent bedrock. No sedimentological information is available for these deposits beyond what may be inferred from landforms and clasts on the ground surface. Large basaltic boulders are widely distributed over the surface of all deposits, suggesting that debris flows may have played a role in their emplacement. However, rounded to subrounded pebbles and cobbles of basaltic rock, which are abundant on the flanks of some deposits, suggest that beds of clast-supported pebble and cobble gravel are also important constituents of the unit. The unit does not appear to contain abundant rock fragments derived from the Green River Formation, as do most deposits of younger gravel. Unit thickness is estimated to be as much as 60 ft.

Qbg_2 — **Middle basaltic boulder gravel (middle Pleistocene)**—Unit consists of extremely poorly sorted boulder to pebble gravel composed predominantly of basaltic rock that caps ridges that typically rise 120 ft, but locally nearly 160 ft, above the upper surface of unit Qhm. The physical characteristics and origin of the sediment are similar to those of unit Qbg_3. Except for one locality (SE¼, NE¼ sec. 1, T. 8 S., R. 93 W.), the unit does not appear to contain abundant rock fragments derived from the Green River Formation, as does most gravel that is younger than Qbg_3. Unit thickness is estimated to be as much as 60 ft.

Qbg_1 — **Old basaltic boulder gravel (middle Pleistocene)**—Unit consists of extremely poorly sorted boulder to pebble gravel composed predominantly of basaltic rock that caps ridges that rise 160–200 ft above the upper surface of unit Qhm. The characteristics and origin of the sediment are similar to those of units Qbg_3 and Qbg_2. Unit thickness is estimated to be as much as 60 ft.

Qgm — **Gravel of Grass Mesa (middle Pleistocene)**—Unit consists mainly of white to light-gray (10YR 8/2, 7/2) beds and lenses (channel fills) of extremely poorly sorted beds of calcareous, clast- and matrix-supported gravel, and clayey silt and silty and clayey sand. Basaltic boulders, some as much as 5 ft in maximum dimension, are common on the surface of the unit and in colluvium derived from the unit. Similar large boulders were not observed in any of the few extensive exposures that exist along the edges of Grass Mesa just west and north of the map area. Clasts of basaltic rocks ranging in size from pebbles to small boulders are present in beds of coarse gravel within the deposit, as are slabs and chips of marlstone and oil shale derived from the Green River Formation. The color of the matrix and the unit as a whole was inherited mainly from the Green River Formation. The unit consists of beds and channel-fill deposits of both debris-flow and fluvial origin. Thickness is as much as 185 ft.

EOLIAN DEPOSITS—Wind-deposited sediment consisting mostly of silt, very fine sand, and fine sand. Windblown sediment is usually well preserved only on level to gently sloping surfaces; elsewhere it tends to have been eroded, reworked, or buried by younger deposits.

Qlo — **Loess (upper and middle? Pleistocene)**—Unit consists of reddish-brown, light-reddish-brown, and light-brown (5YR 5/4, 6/4; 7.5YR 6/4) sandy silt and silty, very fine sand deposited by wind. In most places, contacts are only approximately located because the unit lacks topographic expression and commonly is less than 3 ft thick. The distribution of deposits in the southeast quarter of the map area is partly inferred from 1:24,000-scale soil maps (Harman and Murray, 1985). Although soil maps indicate that loess mantles the western part of sec. 22, the northern part of sec. 35, and most of secs. 23 and 26, T. 7 S., R. 92 W. as well as the eastern edge of sec. 2, T. 8 S., R. 92 W.; it is not shown on the map because surficial deposits across much of this area appear to be less than 4 ft thick. Most of unit Qlo is of late Pleistocene age, but in places, it appears to include deposits of two or three different ages, the oldest of which may be middle Pleistocene. A moderately developed surface soil (A/BA/Bt/Bk/C profile) is present in the unit in most places. Unit may be subject to hydrocompaction where bulk density is low. Thickness is 1–7 ft in most places, but locally is as much as 10–20 ft.

BEDROCK

Green River Formation (Eocene)

Tga — **Anvil Points Member**—Unit consists mainly of light-gray to brown, massive, fine- to coarse-grained sandstone and minor amounts of siltstone and marlstone. Unit is present only in the southwest corner of the quadrangle where about 250 ft of the basal part of the member conformably overlies the Wasatch Formation. The Anvil Points Member is as much as 1500 ft thick just west of the map area (Hail and Smith, 1977).

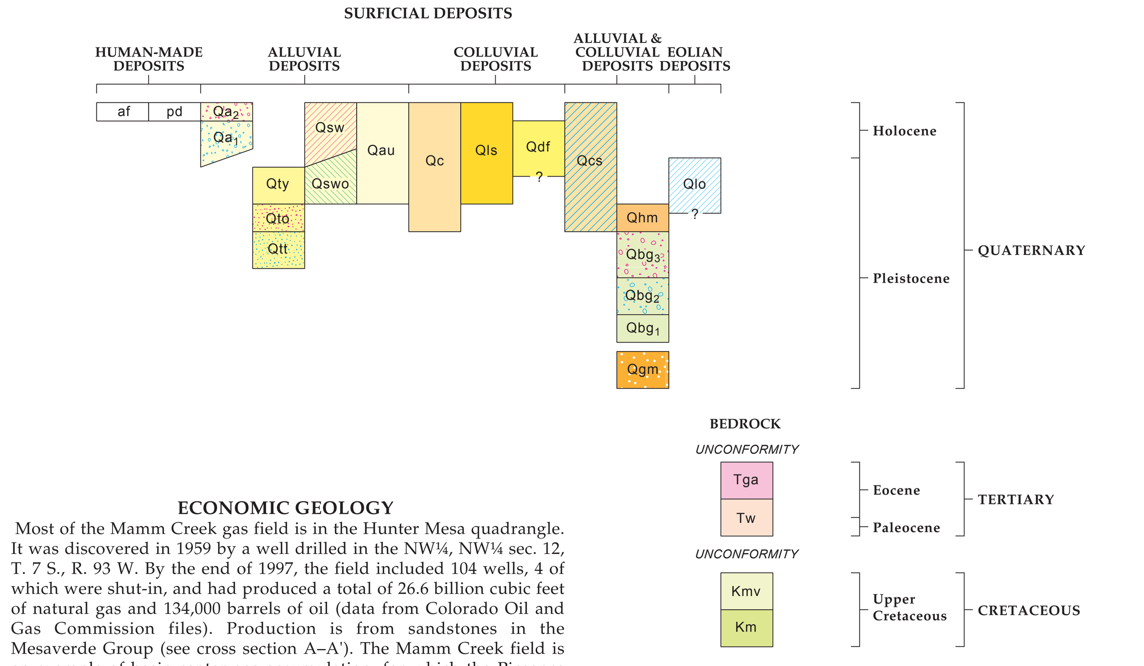
Tw — **Wasatch Formation (Eocene and Paleocene)**—Unit consists of interbedded and lenticular, varicolored gray, grayish-yellow, yellowish- to reddish-brown, and reddish-purple claystone and siltstone, and gray and brown, fine- to coarse-grained sandstone and minor conglomerate. These strata unconformably overlie rocks of the Upper Cretaceous Mesaverde Group, which do not crop out in the map area. Sediment of the Wasatch Formation was derived during Laramide time from the Sawatch Anticline and White River Uplift, which are south and east of the map area (Tweto, 1975). The sediment was deposited in a non-marine, predominantly low-relief fluvial environment that included lakes and ponds. Sandstones of the Wasatch Formation are commonly resistant to erosion. They are the caprock on hills and ridges in the central and northern part of the map area. Several sandstone beds in the lower part of the formation are resistant and more persistent laterally than most beds in the unit. These beds crop out in a cuesta-like ridge along the west flank of the Divide Creek Anticline. The ridge trends northwestward from the southeast corner of the map area, then bends eastward around the nose of the north-northwest-trending anticline. Over most of the map area, regional dip is southwest, west, and north. It ranges from about 12° southwest in the southeastern part of the area to 5° north in the northern part of the area. The Wasatch Formation is at the surface or underlies surficial deposits across the entire Hunter Mesa quadrangle, except for a small area at the southwest corner. West of the map area, Donnell (1969) and Hail and Smith (1997) divided the Wasatch Formation into three members. Scott and Shroba (1997) also mapped the three members in the New Castle quadrangle, which adjoins the map area on the northeast. A similar division of the formation was not practical within the Hunter Mesa quadrangle. The upper part of the unit has been removed by erosion from most of the map area, especially the eastern part. On the basis of well-log data (cross section A–A'), the Wasatch Formation is estimated to be less than 1,000 ft thick near the eastern edge of the map area and more than 5,000 ft thick near the western edge. The formation is 3,400–5,200 ft thick in sections measured near the margin of the Piceance Creek Basin (Hemborg, 1993), and more than 6,000 feet thick, according to geophysical logs of oil and gas wells, within the basin (Snow, 1970). Although the Wasatch Formation does not appear to be prone to landsliding in the Hunter Mesa quadrangle under present climatic conditions, human activities that remove support (excavation), increase soil moisture, or add weight could trigger slope failure in the fine-grained strata of this unit.

Kmv — **Mesaverde Group (Upper Cretaceous)**—Shown only on cross section.

Kir — **Rollins Sandstone Member of Iles Formation, Mesaverde Group (Upper Cretaceous)**—Top shown only on cross section.

Km — **Mancos Shale (Upper Cretaceous)**—Shown only on cross section.

CORRELATION OF MAP UNITS



ECONOMIC GEOLOGY

Most of the Mamm Creek gas field is in the Hunter Mesa quadrangle. It was discovered in 1959 by a well drilled in the NW¼, NW¼ sec. 12, T. 7 S., R. 93 W. By the end of 1997, the field included 104 wells, 4 of which were shut-in, and had produced a total of 26.6 billion cubic feet of natural gas and 134,000 barrels of oil (data from Colorado Oil and Gas Commission files). Production is from sandstones in the Mesaverde Group (see cross section A–A'). The Mamm Creek field is an example of basin-center gas accumulation, for which the Piceance Creek Basin is known. Several surficial deposits in the map area contain gravel, but much of it is matrix supported, and deposits of matrix-supported gravel rarely have commercial value. Even the clast-supported gravels in this area have limited commercial value at present, although some deposits could be exploited for local uses, such as constructing roadbeds. Most of the gravel deposits 1) underlie high terraces and mesas, and are older than 130,000 yr; 2) contain secondary calcium carbonate, much silty and clayey matrix, and abundant large cobbles and boulders; and 3) are mantled by windblown deposits. Extensive deposits of sand and gravel along the Colorado River are of better quality than those in the map area and are closer to population centers.

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MAP SYMBOLS

Contact—Dashed where approximately located; dotted where concealed

Lineament—Possibly controlled by faulting

Anticline—Showing axial trace and direction of plunge; dashed where approximately located; dotted where concealed

Strike and dip of beds

20 — **Inclined**—Measured in the field; angle of dip shown in degrees

Inclined—Directions estimated mostly on the basis of landforms

Wells drilled for oil and gas—Most of the Mamm Creek gas field is in the Hunter Mesa quadrangle. Only the locations of the discovery well and the two wells used in constructing the cross section are shown on the map

Well—Produces natural gas

Well—Dry hole; plugged and abandoned

Basaltic boulders—On outcrops and residium of the Wasatch Formation (sec. 21 and 34, T. 7 S., R. 92 W.) and in small remnants of colluvium or alluvium (SE¼ sec. 34, T. 7 S., R. 92 W., and sec. 13 and 23, T. 7 S., R. 93 W.)

★ C1 — **Locality of radiocarbon sample**

A——A′ — **Alignment of cross section**

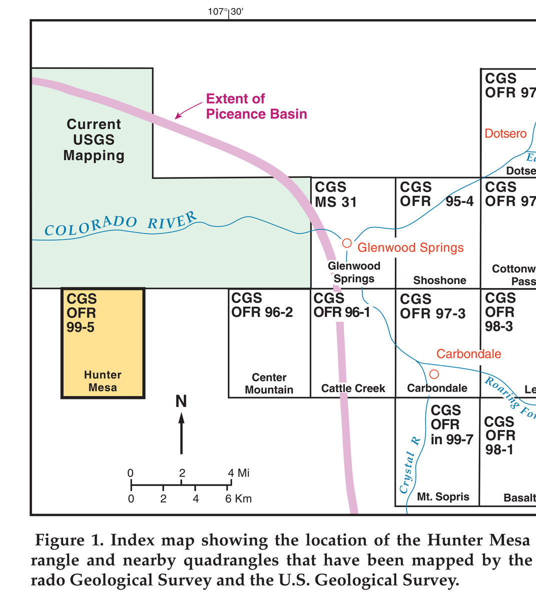


Figure 1. Index map showing the location of the Hunter Mesa quadrangle and nearby quadrangles that have been mapped by the Colorado Geological Survey and the U.S. Geological Survey.

Table 1. Radiocarbon ages and corresponding tree-ring calibrated ages of charcoal from localities in the Hunter Mesa quadrangle, Garfield County, Colorado.

[Rad, radiometric (with extended counting); AMS, accelerator mass spectrometry; $\delta^{13}C$ values given in parts per thousand compared to the standard. Analyses by Beta Analytic Inc., Miami, Fla.]

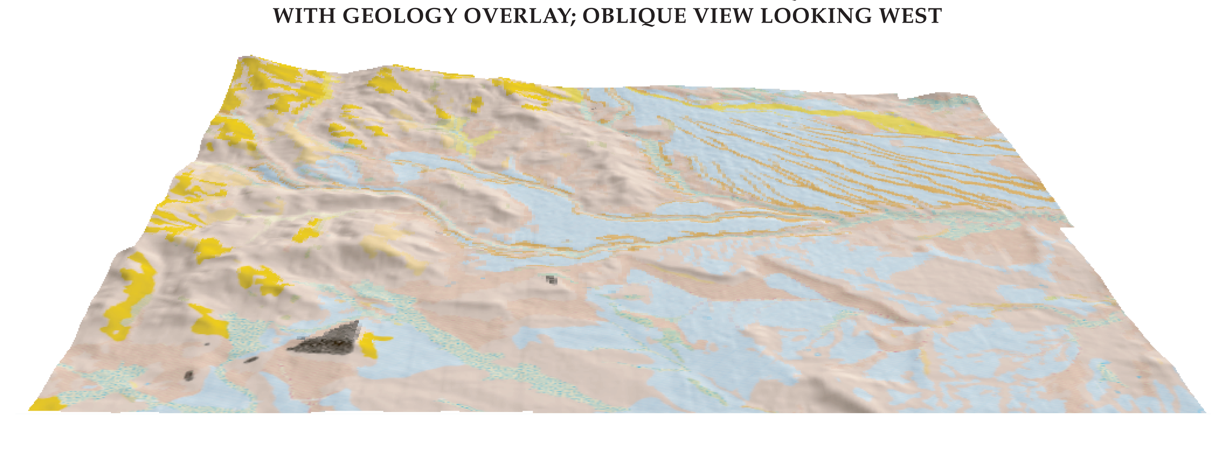
Locality[1]	Method	Laboratory Sample No.	Radiocarbon Age ±1σ (^{14}C yr B.P.)	$\delta^{13}C$ (‰)	Calibrated[2] Age ± 2σ (cal yr A.D.)
C1	Rad	Beta-125168	[3]1,380 ± 50	-25.2	605–760
C2	AMS	Beta-125169	320 ± 60	-25.9	1,495–1,675

1. Radiocarbon sample localities are shown on the map.

2. Tree-ring calibrated ages in calendar years from corresponding radiocarbon ages based on the Pretoria Calibration Procedure program; calibrations by Beta Analytic, Inc. Variation in the production rate of atmospheric radiocarbon over time causes inflections in the tree-ring calibration curve. Hence, some radiocarbon ages intercept the calibration curve more than once and correspond to more than one calendar age or to calendar ages that have larger standard deviations than the radiocarbon age.

3. Conventional radiocarbon age (corrected for isotopic fractionation but not reservoir effects). Age was calculated using a half-life of 5,568 years. The ± 1σ standard deviation represents the combined error in counting the radioactive disintegration of the modern standard, the background, and the sample.

SHADED-RELIEF MAP OF THE HUNTER MESA QUADRANGLE WITH GEOLOGY OVERLAY; OBLIQUE VIEW LOOKING WEST



State of Colorado
Department of Natural Resources
Colorado Geological Survey
Denver, Colorado
1999

GEOLOGIC MAP OF THE HUNTER MESA QUADRANGLE, GARFIELD COUNTY, COLORADO

By Richard F. Madole

1999