U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Black Canyon of the Gunnison National Park and Curecanti National Recreation Area

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area

blca-cure_geology.pdf

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Geologic Resources Inventory Map Document for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area

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Geologic Resources Inventory Map Document

Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, Colorado

Document to Accompany Digital Geologic-GIS Data

blca-cure_geology.pdf

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This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, Colorado (BLCA-CURE).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Map Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5) **Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviations.

6) **Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this may include a stratigraphic column, index map, map legend and/or map notes.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage: http://go.nps.gov/gri_products

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park(s), enter "GRI" as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS map for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, Colorado (BLCA-CURE):

Digital Geologic-GIS Map of Black Canyon of the Gunnison National Park, Curecanti National Recreation Area and Vicinity, Colorado (*GRI MapCode BLCA-CURE*)

The above map was compiled from several component maps that are listed below. For each of these maps the source map citation is also listed. The full extent of each source map was used and all geologic features present on each map including mine point features (e.g., adits, shafts, prospects, mines, gravel pits etc.) were captured. In addition, prominent map components present on each source map (e.g., unit colors, unit descriptions, geologic cross sections and other ancillary map graphics and text) were also incorporated into this GRI digital geologic-GIS dataset and product.

Digital Geologic-GIS Map of the Big Mesa Quadrangle, Colorado (*GRI MapCode BIME*)

Hedlund, D.C., 1974, Geologic Map of the Big Mesa Quadrangle, Gunnison County, Colorado: U. S. Geological Survey, Geological Quadrangle Map GQ-1153, scale 1:24,000 (Big Mesa Quadrangle). (*GRI Source Map ID 26*).

Digital Geologic-GIS Map of Black Canyon of the Gunnison River and Vicinity, Colorado (*GRI MapCode BLCG*)

Hansen, W.R., 1971, Geologic Map of the Black Canyon of the Gunnison River and Vicinity, Western Colorado: U.S. Geological Survey, Miscellaneous Geologic Investigations Map I-584, scale 1:24,000 (Black Canyon of the Gunnison River and Vicinity). (*GRI Source Map ID 8*).

Digital Geologic-GIS Map of the Black Ridge Quadrangle, Colorado (*GRI MapCode BLRG*)

Hansen, W.R., 1968, Geologic Map of the Black Ridge Quadrangle, Delta and Montrose Counties, Colorado: U.S. Geological Survey, Geological Quadrangle Map, GQ-747, scale 1:24,000 (Black Ridge Quadrangle). (*GRI Source Map ID 1*).

Digital Geologic-GIS Map of the Cerro Summit Quadrangle, Colorado (*GRI MapCode CESU*)

Dickinson, R.G., 1965, Geologic Map of the Cerro Summit Quadrangle, Montrose County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-486, scale 1:24,000 (Cerro Summit Quadrangle). (*GRI Source Map ID 3*).

Digital Geologic-GIS Map of the Carpenter Ridge Quadrangle, Colorado (*GRI MapCode CRRI*)

Hedlund, D.C., and Olson, J.C., 1973, Geologic Map of the Carpenter Ridge Quadrangle, Gunnison County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1070, scale 1:24,000 (Carpenter Ridge Quadrangle). (*GRI Source Map ID 27*).

Digital Geologic-GIS Map of the Gateview Quadrangle, Colorado (*GRI MapCode GATV*)

Olson, J.C., and Hedlund, D.C., 1973, Geologic Map of the Gateview Quadrangle, Gunnison County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1071, scale 1:24,000 (Gateview Quadrangle). (*GRI Source Map ID 28*).

Digital Geologic-GIS Map of the Gunnison Quadrangle, Colorado (*GRI MapCode GUNN*)

Stork, Allen, Coogan, James C., Csar, Alex, and Wentz, Raelene, 2006, Geologic Map of the Gunnison Quadrangle, Gunnison County, Colorado: Colorado Geological Survey, Open-File

Report OF-06-04, scale 1:24,000 (Gunnison Quadrangle). (*GRI Source Map ID 76271*).

Digital Geologic-GIS Map of the Iris NW Quadrangle, Colorado (*GRI MapCode IRNW*)

Hedlund, D.C., and Olson, J.C., 1973, Geologic Map of the Iris NW Quadrangle, Gunnison and Saguache Counties, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1134, scale 1:24,000 (Iris NW Quadrangle). (*GRI Source Map ID 29*).

Digital Geologic-GIS Map of the Little Soap Park Quadrangle, Colorado (*GRI MapCode LISP*)

Gaskill, D., Stork, A., Fillmore, R., and Coven, B., 1999, Geologic Map of the Little Soap Park Quadrangle: Western State College of Colorado, unpublished map, scale 1:24,000 (Little Soap Park Quadrangle). (*GRI Source Map ID 934*).

Digital Geologic-GIS Map of the McIntosh Mountain Quadrangle, Colorado (*GRI MapCode MCMO*)

Stork, A., Panter, K., Murphy, R., and Stooksbury, B., 1999, Geologic Map of the McIntosh Mountain Quadrangle: Western State College of Colorado, unpublished map, scale 1:24,000 (McIntosh Mountain Quadrangle). (*GRI Source Map ID 935*).

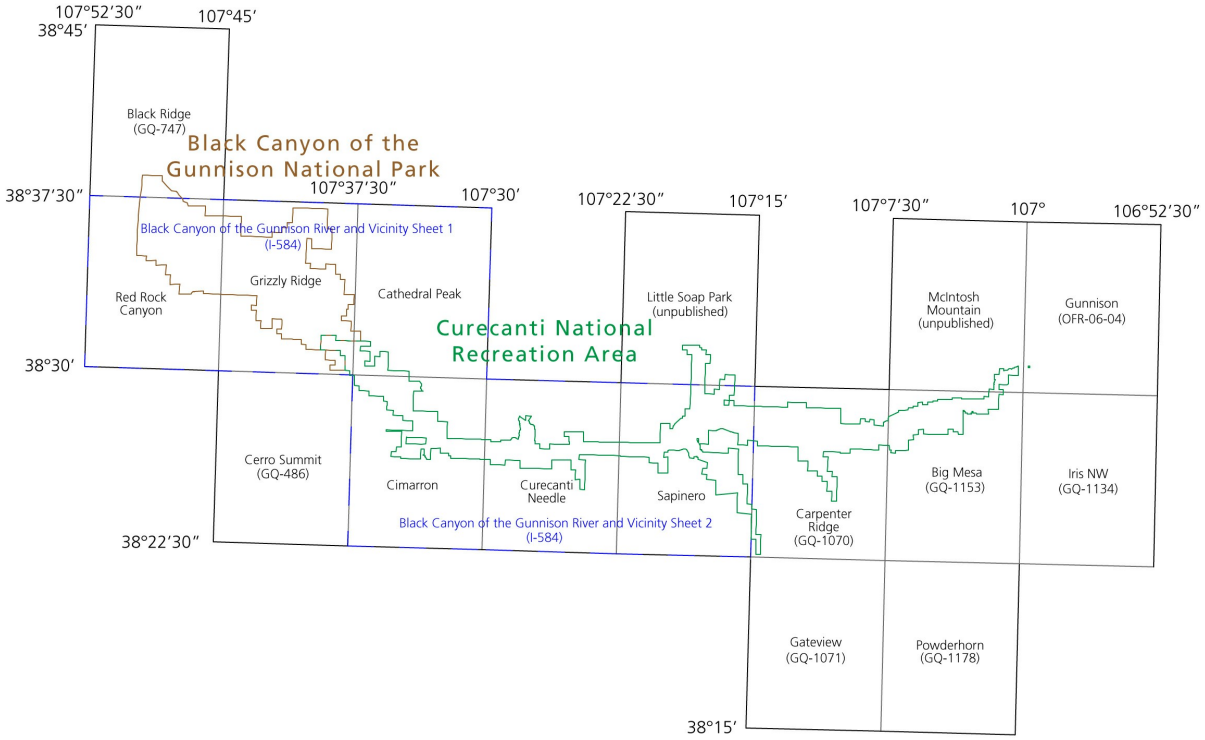
Digital Geologic-GIS Map of the Powderhorn Quadrangle, Colorado (*GRI MapCode POWD*)

Hedlund, D.C., and Olson, J.C., 1975, Geologic Map of the Powderhorn Quadrangle, Gunnison and Saguache Counties, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1178, scale 1:24,000 (Powderhorn Quadrangle). (*GRI Source Map ID 30*).

Additional information pertaining to each source map is also presented in the GRI Source Map Information (BLCA-CUREMAP) table included with the GRI geologic-GIS data.

Index Map

The following index map displays the extent of GRI digital geologic-GIS maps produced for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area. The extent of the Digital Geologic-GIS Map of Black Canyon of the Gunnison National Park, Curecanti National Recreation Area and Vicinity (BLCA-CURE map) is outlined with a black line and includes all of the 7.5' quadrangles shown below. In addition to the aforementioned map, the GRI also completed several component maps that collectively comprise this map. One such map is the Digital Geologic-GIS Map of Black Canyon of the Gunnison River and Vicinity (BLCG map; outlined with a dashed blue line). This map includes the following 7.5' quadrangles: Cathedral Peak, Cimarron, Curecanti Needle, Grizzly Ridge, Red Rock Canyon and Sapinero. The U.S. Geological Survey source map series number, I-584,is also shown. Component Digital Geologic-GIS maps were also produced for the following 7.5' quadrangles: Big Mesa, Black Ridge, Carpenter Ridge, Cerro Summit, Gateview, Gunnison, Iris NW, Little Soap Park, McIntosh Mountain and Powderhorn. For each published quadrangle map the U.S. Geological Survey source map series number (e.g., GQ-747) is also indicated. The boundaries for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area (as of March, 2019) are outlined in brown and green, respectively.



Index map produced by James Winter (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, Colorado (BLCA-CURE) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Q - Quaternary deposits, undifferentiated). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (BLCA-CUREUNIT) table included with the GRI geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Q - Quaternary deposits, undifferentiated
Qla - Active and recent landslide deposits
Qaf - Artificial fill and disturbed surfaces
Qvay - Valley alluvium, younger
Qa - Stream and flood-plain alluvium
Qce - Eolian colluvium
Qf - Fan deposits
Qtsc - Younger talus, slope wash, or colluvium, undivided
Ql - Landslide deposits
Qe - Eolian deposits
Qst0 - Stream terrace alluvium, youngest
Qfa - Alluvial-fan deposits, younger
Qdf - Debris-fan deposits
Qc - Colluvium
Qac - Alluvium and colluvium
Qab - Alluvial fill in Bostwick Park
Qvao - Valley alluvium, older
Qtpg - Terrace and pediment gravel
Qls - Mass-movement deposits, undivided
Qtr - Travertine, younger
Qef - Earthflow deposits
Qlm - Prominent earthflow and mudflow lobes
Qvf - Valley-fill deposits of Bostwick-Shinn Park
    Qvfva - Valley-fill deposits of Bostwick-Shinn Park, volcanic ash a
    Qvfvb - Valley-fill deposits of Bostwick-Shinn Park, volcanic ash b
Qpa - Pediment remnant
Qpb - Highest pediment remnant
Qst1 - Stream terrace alluvium, younger
Qtu1 - Terrace and pediment deposits graded to former base levels of the Uncompahgre River
Qta1 - Terrace and pediment deposits along Alkali Creek, Onion Valley, and Crystal Creek
Qt1 - Terrace deposits of Cimarron and Blue Creek drainages, youngest
Qt2 - Terrace deposits of Cimarron and Blue Creek drainages, younger
Qtu2 - Terrace and pediment deposits graded to former base levels of the Uncompahgre River of pre-Wisconsinan(?) age
Qta2 - Terrace and pediment deposits along Alkali Creek, Onion Valley, and Crystal Creek of pre-Wisconsinan(?) age
Qt3 - Terrace deposits of Cimarron and Blue Creek drainages, older

Qfo - Alluvial-fan deposits, older
Qt - Terrace deposits, undifferentiated (Kansan(?) or older)
Qbo1 - Boulder gravel deposits, younger
Qtu3 - Terrace and pediment deposits graded to former base levels of the Uncompahgre River
Qt4 - Terrace deposits of Cimarron and Blue Creek drainages, oldest
Qbo2 - Boulder gravel deposits, older
Qst2 - Stream terrace alluvium, older
Qlso - Mass-movement deposits, older
Qtg - Terrace gravels
Qsg - Older stream gravel of Shinn Park
Qtb - Terrace and alluvial fan deposits in Bostwick Park and vicinity

Quaternary and Tertiary Periods
QTb - Boulder gravel deposits along west margin of Bostwick Park
QTgd - Gravel deposits
QTl - Older landslide deposit on Waterdog Peak

Tertiary Period
Tc - Conglomerate on Poverty Mesa
Hinsdale Formation
- Th - Hinsdale Formation, latite to basalt
- Thg - Hinsdale Formation, coarse gravel

Tmvg - Gravel of MacIntosh Mountain, volcanic gravel
Tmpg - Gravel of MacIntosh Mountain, Precambrian-bearing gravels
Tcav - Calcite veins
Tgb - Gravel, breccia and sand deposits
Tg - Tertiary gravel deposits
Tlg - Tuff of Long Gultch
Tr - Rat Creek(?) Tuff
Tcu - Carpenter Ridge Tuff, undivided
- Tcb - Carpenter Ridge Tuff, tuffaceous breccia
- Tca - Carpenter Ridge Tuff, ash-flow tuff
- Tcv - Carpenter Ridge Tuff, dark-brown to black vitrophyre
- Tcn - Carpenter Ridge Tuff, nonwelded ash-flow tuff
- Tcvg - Carpenter Ridge Tuff, volcanic gravels

Tfu - Fish Canyon Tuff, undivided
- Tfa - Fish Canyon Tuff, ash-flow tuff
- Tfn - Fish Canyon Tuff, nonwelded ash-flow tuff
- Tfv - Fish Canyon Tuff, vitric tuff
- Tfg - Fish Canyon Tuff, coarse gravel
- Tfvg - Fish Canyon Tuff, volcanic gravels

Tsmu - Sapinero Mesa Tuff, undivided
- Tsma - Sapinero Mesa Tuff, ash-flow tuff
- Tsmn - Sapinero Mesa Tuff, nonwelded pumiceous tuff
- Tsmv - Sapinero Mesa Tuff, vitrophyre
- Tsmg - Sapinero Mesa Tuff, gravel
- Tsmvg - Sapinero Mesa Tuff, volcanic gravels

Tgo - Older Tertiary gravel deposits, undifferentiated
Tdmu - Dillon Mesa Tuff, undivided
- Tdmb - Dillon Mesa Tuff, tuffaceous breccia
- Tdmw - Dillon Mesa Tuff, nonwelded and moderately welded air-fall tuff
- Tdmv - Dillon Mesa Tuff, vitrophyre
- Tdmg - Dillon Mesa Tuff, gravel

Tdmbm - Dillon Mesa and Blue Mesa Tuffs, undivided, air-fall tuff, tuffaceous sediments, and travertine
Tdmbmb - Dillon Mesa and Blue Mesa Tuffs, undivided, tuff breccia
Tbmu - Blue Mesa Tuff, undivided

Tbmaw - Blue Mesa Tuff, ash-flow tuff and devitrified welded tuff
Tbmg - Blue Mesa Tuff, gravel
Tbmv - Blue Mesa Tuff, vitrophyre
Tbmpg - Blue Mesa Tuff, Precambrian-bearing gravels
Ttsc - Talus, slope wash or colluvium, undivided
Ttr - Travertine, older
Tj - Jasper or siliceous sinter
Lake Formation
Tl - Lake Fork Formation, hornblende rhyodacite flows
Tld - Lake Fork Formation, rhyodacite dike
Tll - Lake Fork Formation, quartz latite flows, autobreccia, and thin basal sedimentary breccia
Tlb - Lake Fork Formation, andesitic to quartz-latitic volcanic breccia
Tlt - Lake Fork Formation, pumiceous tuff
Tlgc - Lake Fork Formation, tuffaceous gravel and volcanic conglomerate
Tla - Lake Fork Formation, andesite flows and autobreccia
Tlba - Lake Fork Formation, porphyritic andesite
Te - Bedded tuffs of East Elk Creek
Twu - West Elk Breccia, undivided
Twc - West Elk Breccia, tuff and tuffaceous conglomerate
Twt - West Elk Breccia, laharic volcanic breccia and tuff breccia
Twf - West Elk Breccia, hornblende rhyodacite
Twa - West Elk Breccia, ash-flow tuff lens
Twg - Gravels of the East Elk Tuff and West Elk Breccia
Twr - West Elk Breccia, rhyolite and dacite domes
Twbc - West Elk Breccia, basal cone facies

Mesozoic Era

Cretaceous Period

Kcr - Cimarron Ridge Formation
Kc - Camptonite
Kf - Fruitland Formation
Kfc - Fruitland Formation, coal bed at base of formation
Kpc - Pictured Cliffs Sandstone
Km - Mancos Shale, undivided
Kms - Mancos Shale, silty-marker bed
Kmjl - Mancos Shale, top of Juan Lopez Member
Kd - Dakota Sandstone
Kdbc - Dakota Sandstone and Burro Canyon(?) Formation, undivided
Kbc - Burro Canyon Formation

Jurassic Period

Jm - Morrison Formation
Jmb - Morrison Formation, Brushy Basin Member
Jw - Wanakah Formation
Jj - Junction Creek Sandstone
Je - Entrada Sandstone

Paleozoic Era

Ordovician and Cambrian Periods

OCd - Diabase dikes

Paleozoic Era and/or Precambrian Eon

Cambrian Period and/or Precambrian Eon
CPCt - Thorium veins
CPCtd - Trachyte and trachyte porphyry dikes
CPCc - Carbonatite
CPCns - Nepheline syenite
CPCps - Pyroxenite-nepheline syenite hybrid rock
CPCi - Ijolite
CPCmt - Magnetite-ilmenite-perovskite dikes and segregations
CPCp - Pyroxenite
CPCmo - Melanite-orthoclase rock
CPCbx - Intrusive breccia

Precambrian Eon

PCqv - Quartz veins
PCfg - Fine-to medium-grained granite
PCwc - Granite dikes of Wolf Creek
PCmi - Minette
PCcs - Coarse-grained biotite syenite and hornblende syenite
PCsy - Quartz syenite, syenite, and granite
PCcms - Calcite-rich mafic syenite
PCbs - Biotite syenite
PCas - Augite syenite
PCop - Olivine pyroxenite
PCmr - Metarhyolite dikes
PCfs - Fine-grained melasyenite
PCps - Gray porphyritic syenite
PCms - Melasyenite
PCc - Curecanti Quartz Monzonite
PCg - Gabbro
PCp - Pegmatite
PCv - Vernal Mesa Quartz Monzonite
PCgqm - Granite and quartz monzonite
PCl - Lamprophyre
Pitts Meadow Granodiorite
- PCpm - Pitts Meadow Granodiorite,predominant-light colored phase
- PCpv - Pitts Meadow Granodiorite, dark-colored variant

PCcg - Granite and quartz syenite of Carpenter Gultch
PCgpg - Leucogranite and quartz monzonite
PCpo - Powderhorn Granite
PCgb - Quartz diorite to quartz monzonite of Gold Basin
PCtp - Granite of Tolvar Peak
PCgr - Granophyre
Granite of South Beaver Creek
- PCsbg - Granite of South Beaver Creek, granite to granodiorite
- PCsbp - Granite of South Beaver Creek, granite to quartz monzonite porphyry

PCqd - Quartz diorite
PCm - Mica schist
PCsgm - Metamorphic rocks, schist, gneiss and/or migmatite
PCgl - Layered quartzitic gneiss
PCbt - Quartz-biotite gneiss and migmatite
PCa - Amphibolite
PCgq - Massive quartzitic gneiss, and schist and gneiss
PCf - Quartzo-feldspathic gneiss

PCqf - Quartzo-feldspathic and quartz-sericite schist
PCbq - Quartzite and quartz-sericite schist
PCqt - Quartzite (metachert?)
PCh - Hornblende schist and amphibolite
Dubois Greenstone
- PCdh - Dubois Greenstone, hornblende schist and amphibolite
- PCds - Dubois Greenstone, quartzite and quartz-sericite schist
- PCdq - Dubois Greenstone, quartzite
- PCdb - Dubios Greenstone, quartz-biotite-calcite schist
- PCdag - Dubois Greenstone, amphibolite-granite hybrid rock of Carpenter Gulch
- PCdf - Dubois Greenstone, felsite and felsite porphyry
- PCdc - Dubois Greenstone, quartzite conglomerate
- PCda - Dubois Greenstone, coarse-grained amphibolite, metadiortie, and metagabbro

Indeterminable Age
fault zone

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. As many unit symbols (e.g., Ql) were changed in the GRI digital geologic-GIS data and compilation, references to unit symbols within unit descriptions may not be accurate with respect to the unit's symbol in the unit listing and descriptions.

Q - Quaternary deposits, undifferentiated (Quaternary)

Unit only present in cross section. Unit present on source map: Gunnison Quadrangle

Qla - Active and recent landslide deposits (Recent)

Ql - Landslides and mudflows (Holocene)
Heterogeneous mixtures of clay, silt, sand, pebbles, cobbles, and boulders, locally derived and deposited as landslide masses. Commonly tens of feet thick. Typically exposed along both sides of the Gunnison River where weak volcanic breccias and tuffaceous conglomerates underlie competent beds of welded tuff. A small landslide in Lake Gulch (sec. 3,T.48N., R.3W.) appears to have blocked this intermittent stream recently. Description from source map: Big Mesa Quadrangle

Ql - Landslides, mudflows, and debris flows (Recent)
Heterogeneous mixtures of boulders, cobbles, pebble gravel, sand, silt, and clay. Includes eroded remnants of old deposits as well as actively moving ones. Description from source map: Black Ridge Quadrangle

Ql - Surficial deposits, landslides and mudflows (Holocene)
Heterogeneous mixtures of clay to boulder-sized fragments locally derived and deposited as landslide masses; flowage of water-saturated landslide debris formed mudflow deposits. Commonly tens of feet thick. Description from source map: Carpenter Ridge Quadrangle

Qla - Active landslide deposits (Recent)
Slump and earthflow composed mostly of Mancos Shale. Disturbed roads and fence lines indicate landslides are active. Many small slides near ditches and springs not mapped. Description from source map: Cerro Summit Quadrangle

Ql - Surficial deposits, landslides (Pleistocene and Holocene)
Heterogeneous mixtures of clay, silt, sand, pebbles, cobbles, and boulders; locally derived and deposited as landslide masses. The Lake Fork landslide in sec. 20, T.47N., R.3W., now somewhat dissected, was probably about 400 feet thick originally. Description from source map: Gateview Quadrangle

Ql - Landslide Deposits (Holocene)
Heterogeneous mixtures of rock fragments of various sizes, locally derived and deposited as landslide masses. Description from source map: Powderhorn Quadrangle

Qaf - Artificial fill and disturbed surfaces (latest Holocene)

af - Human-Made Deposits, Artificial fill and disturbed surfaces (latest Holocene)
Unsorted sand, silt, gravel, or rock fragments, that may contain construction material deposited as spoils from quarrying operations, as flood-control and airport construction, or as landfills. Description from source map: Gunnison Quadrangle

Qvay - Valley alluvium, younger (Recent)

Qva - Valley alluvium (Recent)
Mostly poorly sorted gravel, sand, and silt along Smith Fork and Crystal Creek; includes rubbly torrential fan deposits containing many boulders. Fine sand and silt on upland surfaces of Fruitland Mesa and Green Mountain. Description from source map: Black Ridge Quadrangle

Qa - Stream and flood-plain alluvium (Holocene)

Qa - Alluvium (Holocene and Pleistocene?)
Sand and silt deposits and poorly sorted gravel containing boulders, cobbles, or fragments of various Precambrian, Mesozoic, and Cenozoic rocks. Thickness commonly exceeds 10 feetDescription from source map: Big Mesa Quadrangle

Qa - Surficial deposits, alluvium (Holocene)
Poorly sorted gravel, sand, and silt deposits containing boulders, cobbles, or fragments of various Precambrian, Mesozoic, and Cenozoic rocks. Thickness commonly exceeds 10 feet. Description from source map: Carpenter Ridge Quadrangle

Qa - Surficial deposits, alluvium (Pleistocene and Holocene)
Poorly sorted gravel, sand, and silt deposits containing boulders, cobbles, or fragments of various Precambrian, Mesozoic, and Cenozoic rocks. Includes glacial outwash gravels of Wisconsin and Durango ages is Lake Fork Valley. Thickness commonly exceeds 10 feet. Description from source map: Gateview Quadrangle

Qa - Alluvial Deposits, Stream and flood-plain alluvium (Holocene)
Sand, silt, clay, and gravel in channels and flood plains; composition depends on source area; 0 to 40 m (0 to 130 ft.) thick. Description from source map: Gunnison Quadrangle

Qa - Alluvium (Holocene)
Sand and silt deposits and poorly sorted gravel containing boulders, cobbles, or fragments of various Precambrian, Mesozoic, and Cenozoic rocks. Thickness commonly exceeds 10 feet. Description from source map: Iris NW Quadrangle

Qa - Alluvium (Holocene and Pleistocene)
Sand and silt deposits and poorly sorted gravel containing boulders, cobbles or fragments of various Precambrian, Mesozoic, and Cenozoic rocks that are associated with currently active drainages. Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Qa - Alluvium (Holocene)
Poorly sorted gravel, sand, and silt deposits containing boulders, cobbles, or fragments of various Precambrian, Mesozoic, and Cenozoic rocks. May include glacial outwash gravels of Wisconsin age along Cebolla Creek. Poor drainage along Willow Creek has resulted in deposition of lacustrine silt deposits along parts of the valley. Thickness commonly exceeds 10 feet. Description from source map: Powderhorn Quadrangle

Qce - Eolian colluvium (Holocene)

Qce - Mass-Wasting Deposits, Eolian colluvium (Holocene)
Poorly stratified sand and silt that accumulate in drainages on the lee side of ridges; initially deposited by eolian processes and modified by variety of processes, including slopewash and soil creep, with minor fluvial reworking; 0 to 6 m (0 to 20 ft.) thick. Description from source map: Gunnison Quadrangle

Qf - Fan deposits (Holocene)

Qf - Surficial deposits, fan deposits (Holocene)
Torrential fan deposits containing subangular to angular, poorly sorted, locally derived boulders and gravel. Commonly exceeds 10 feet in thickness. Description from source map: Carpenter Ridge Quadrangle

Qf - Fan deposits (Holocene)
Torrential fan deposits containing subangular to angular, poorly sorted, locally derived boulders and gravel. Commonly exceeds 10 feet in thickness. Description from source maps: Iris NW Quadrangle and Powderhorn Quadrangle

Qtsc - Younger talus, slope wash, or colluvium, undivided (Holocene)

Qt - Talus, slope wash, and colluvium, undifferentiated (Holocene and Pleistocene?)
Poorly sorted, unconsolidated, locally derived rock fragments, angular boulders, rubble, and soil; deposited chiefly by gravity on or at the foot of a slope. Commonly several feet thick. Description from source map: Big Mesa Quadrangle

Qts - Talus (Quaternary)
Bouldery angular rubble; also includes rock streams, some coarse slope wash, torrential fan deposits, and some gravel bars along Gunnison River. Arrow denotes place of inferred activity at time of mapping. Commonly tens of feet thick, but highly variable. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qts - Talus (Recent)
Bouldery angular rubble. Includes some coarse slope wash and some gravel bars along the Gunnison River. Description from source map: Black Ridge Quadrangle

Qt - Surficial deposits, talus, slope wash, or colluvium, undifferentiated (Holocene)
Poorly sorted, unconsolidated, locally derived rock fragments, angular boulders, rubble, and soil: deposited chiefly by gravity on or at the foot of a slope. Commonly several feet thick. Description from source map: Carpenter Ridge Quadrangle

Qt - Surficial deposits, talus, slope wash, and colluvium, undifferentiated (Pleistocene and Holocene)
Poorly sorted, unconsolidated, locally derived rock fragments and soil; deposited chiefly by gravity on or at the foot of a slope. Commonly several feet thick. Description from source map: Gateview Quadrangle

Qt - Talus, slope wash, and colluvium, undifferentiated (Holocene)
Poorly sorted, unconsolidated, locally derived rock fragments and soil; deposited chiefly by gravity on or at the foot of a slope. Commonly several feet thick. Description from source map: Iris NW Quadrangle

Qt - Talus, slope wash, and colluvium, undifferentiated (Holocene and Pleistocene)
Poorly sorted, unconsolidated, locally derived rock fragments, angular boulders, rubble, and soil; mapped where thick enough to cover underlying units. Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Qt - Talus, slope wash, or colluvium, undivided (Holocene)
Poorly sorted, unconsolidated, locally derived rock fragments, angular boulders, rubble, and soil;

deposited chiefly by gravity on or at the foot of a slope. Thickness commonly exceeds 10 feet. Description from source map: Powderhorn Quadrangle

Ql - Landslide deposits (Holocene and Pleistocene)

Ql - Landslides, mudflows, and debris flows (Quaternary)
Heterogeneous mixture of clay, silt, sand, pebbles, cobbles, and boulders. Includes eroded remnants and bouldery residue. Old deposit capping a 9,465-foot hill, southwest of Diehl Point, may be as old as Pliocene. Arrow denotes area of movement at time of mapping. Commonly tens of feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Ql - Landslide deposits (Recent and Pleistocene)
Heterogeneous deposits formed largely by repeated complex slump, mudflow, earthflow, and rockfall movements. Materials from local and adjacent sources mixed in varying degrees. Mostly underlain by Mancos Shale. Surficial expression hummocky and boulder strewn; usually expressed on aerial photographs by characteristic vegetational patterns. Description from source map: Cerro Summit Quadrangle

Ql - Landslide deposits (Quaternary)
No additional description provided on source map. Unit present on source maps:: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Qe - Eolian deposits (Holocene and Pleistocene)

Qe - Eolian deposits (Recent and Pleistocene)
Dune deposits of fine sand, silt, and clay. Pleistocene age of some dunes indicated by soil profiles and geomorphic relationships. Description from source map: Cerro Summit Quadrangle

Qst0 - Stream terrace alluvium, youngest (Holocene and upper Pleistocene)

Qt0 - Alluvial Deposits, Stream terrace alluvium (Holocene to upper Pleistocene)
Sand, silt, clay, and gravel in a terrace above the modern flood-plains; terrace 0-3 m (0-10 ft.) above Qa with the height of the terrace diminishing downstream. Description from source map: Gunnison Quadrangle

Qfa - Alluvial-fan deposits, younger (Holocene and upper Pleistocene)

Qf - Fan deposits (Holocene and Pleistocene?)
Torrential fan deposits containing subangular to angular, poorly sorted, locally derived boulders and gravel. Description from source map: Big Mesa Quadrangle

Qf - Surficial deposits, fan deposits (Pleistocene and Holocene)
Torrential fan deposits containing subangular to angular, locally derived boulders and gravel. Commonly exceeds 10 feet in thickness. Description from source map: Gateview Quadrangle

Qf - Alluvial Deposits, Alluvial-fan deposits (Holocene to upper Pleistocene)
Mostly poorly stratified and poorly sorted sand, silt, and gravel deposited mainly by a combination of debris flow and alluvial processes at the mouths of drainages; generally less than 20 m (65 ft.) thick. Holocene alluvial-fan deposits are not incised and are graded to modern flood plains. Description from source map: Gunnison Quadrangle

Qf - Fan deposits (Holocene and Pleistocene?)
Alluvial fan deposits containing subangular to angular, poorly sorted, locally derived boulders and gravels. Fans are formed from the steep tributaries of Beaver, Steuben, and Stevens Creeks Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Qdf - Debris-fan deposits (Holocene and upper Pleistocene)

Qdf - Alluvial Deposits, Debris-fan deposits (Holocene and upper Pleistocene)
Mostly poorly stratified and poorly sorted sand and gravel that is commonly angular; deposited mainly by rockfall and sheetwash at the base of steep slopes; generally less than 12 m (40 ft.) thick. Description from source map: Gunnison Quadrangle

Qc - Colluvium (Holocene and upper Pleistocene)

Qc - Mass-Wasting Deposits, Colluvium (Holocene and upper Pleistocene)
Poorly stratified sand, silt, and gravel that caps hilltops and gentle to moderate slopes; deposited by a variety of processes, including slopewash and soil creep; composition depends on local bedrock; generally less than 6 m (20 ft.) thick. Colluvium on slopes southwest of Tenderfoot Mountain (Section 13 T. 49 N. R. 1 W.) is deeply incised by Holocene drainages and may be upper Pleistocene in age. Description from source map: Gunnison Quadrangle

Qac - Alluvium and colluvium (Holocene and upper Pleistocene)

Qac - Alluvial and colluvial deposits (Pleistocene)
Sand and gravel along streams, alluvial fan gravels, and local accumulations of slope wash. Pleistocene age of some deposits based on geomorphic relationships. Description from source map: Cerro Summit Quadrangle

Qac - Alluvial and Mass-Wasting Deposits, Alluvium and colluvium (Holocene and upper Pleistocene)
Includes stream and fan alluvium and colluvium; Holocene deposits are not incised and are graded to modern flood plains, whereas upper Pleistocene deposits are incised and are graded to upper Pleistocene alluvial terraces; generally less than 6 m (20 ft.) thick. Description from source map: Gunnison Quadrangle

Qab - Alluvial fill in Bostwick Park (Holocene and Pleistocene)

A succession of silty sands and gravels, mostly derived locally, underlain by well-rounded, well-sorted stream gravels derived largely from volcanic terraces in the San Juan Mountains. As much as 175 feet thick along valley axis, but thins laterally. Near base contains volcanic ash petrographically like Pearlette Ash Member of the Sappa Formation (late Kansan). *Note:* Bostwick Park is a beheaded remnant of a major Pleistocene valley that headed south in the San Juan Mountain and drained north into the Gunnison River via Red Rock Canyon. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qvao - Valley alluvium, older (Holocene and Pleistocene)

Qva - Valley alluvium (Quaternary)
Mostly poorly sorted gravel, sand, and silt deposits graded to modern trunk drainage or incised by recent gullying. Consists mostly of silt in south half of Red Rock Canyon quadrangle and silty sand along Onion Valley in Cathedral Peak quadrangle. Includes some organic silt deposits in bog environments. Thickness generally >10 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qtpg - Terrace and pediment gravel (Holocene and Pleistocene?)

Qg - Terrace and pediment gravel (Holocene and Pleistocene?)
Older alluvial gravel on stream terraces on both sides of the Gunnison River; pediment gravel on abraded surface 2 miles west of Blaine Rock. Description from source map: Big Mesa Quadrangle

Qg - Terrace gravel (Pleistocene)
Small discontinuous terrace remnants at various heights above modern drainage, consisting mostly of poorly sorted cobble to pebble gravel derived from Precambrian and Tertiary volcanic terranes; contains scattered boulders. Description from source map: Black Ridge Quadrangle

Qg - Terrace and pediment gravel (Recent and Pleistocene)
Older alluvial gravel on stream terraces on both sides of the Gunnison River and pediment gravel in Kezar Basin and along Wolf Creek. In secs. 28 and 29, T.49N., R.3W., on the south side of the river, at least four terrace levels of gravel can be mapped on an abraded surface of Precambrian rocks at elevations of 7,410, 7,360, 7,340, and 7,320 feet. In this area, the Gunnison River has apparently migrated laterally to the north down the slope of the surface out on Precambrian rocks. Description from source map: Carpenter Ridge Quadrangle

Qg - Terrace gravel (Holocene and Pleistocene)
Older alluvial gravel on stream terraces associated with the Gunnison River and Beaver Creek. Description from source map: McIntosh Mountain Quadrangle

Qls - Mass-movement deposits, undivided (Holocene and Pleistocene)

Qls - Mass-Wasting Deposits, Mass-movement deposits, undivided (Holocene to upper Pleistocene)
Includes slides, slumps, and flows, as well as colluvium and talus mapped on and adjacent to steep slopes where several mass-movement processes contribute to the deposit; composition varies from poorly sorted clay to boulder-sized material depending on local source terrain; generally characterized by hummocky topography, head and internal scarps, and chaotic bedding in displaced bedrock; morphology is subdued with age; thicknesses are highly variable from 0 to 12 m (0 to 40 ft.) thick. Description from source map: Gunnison Quadrangle

Qtr - Travertine, younger (Holocene and Pleistocene?)

Qtr - Travertine (Holocene and Pleistocene?)
Spring deposits of aragonite breccia near active springs along concealed parts of the Cimarron fault. Description from source map: Powderhorn Quadrangle

Qef - Earthflow deposits (Holocene? and Pleistocene?)

Qef - Mass-Wasting Deposits, Earthflow deposits (Holocene? to Pleistocene?)
Large-scale earthflows exhibiting internal flow or hummocky morphology; originate in clay-rich bedrock of the Cretaceous Mancos Shale and downslope from unconsolidated Quaternary deposits; up to 6 m (20 ft.) thick. Description from source map: Gunnison Quadrangle

Qlm - Prominent earthflow and mudflow lobes (Pleistocene)

Only most prominent shown. Boundaries and extent based mostly on photogeologic, vegetational, and topographic expression. Description from source map: Cerro Summit Quadrangle

Qvf - Valley-fill deposits of Bostwick-Shinn Park (Pleistocene)

(0-250 ft.) Alluvium and colluvium deposited in a valley cut in early Pleistocene time. Locally as much as 120 feet of coarse stream gravel at base; rocks are mostly porphyritic volcanic types. Stream gravel locally overlain by about 200 feet of colluvium derived in part from adjacent sources; includes rock types from most adjacent outcrops. Soil profiles exposed in an outcrop north of Ellison Gulch suggest deposition continued until late Pleistocene. Description from source map: Cerro Summit Quadrangle

Qvfva - Valley-fill deposits of Bostwick-Shinn Park, volcanic ash a (Pleistocene)

va - Valley-fill deposits of Bostwick-Shinn Park, volcanic ash (Quaternary)
Rhyolitic, forms scattered lenses 2-6 feet long and as much as 8 inches thick about 70 feet below top of valley-fill deposits. Description from source map: Cerro Summit Quadrangle

Qvfvb - Valley-fill deposits of Bostwick-Shinn Park, volcanic ash b (Pleistocene)

vb - Valley-fill deposits of Bostwick-Shinn Park, volcanic ash (Quaternary)
(0-2 ft.) Rhyolitic, about 140 feet below Qva. Continuity of discontinuous exposures not definitely established. Mineralogically similar to Pearlette Ash Member (late Kansan) of Sappa Formation in Nebraska. Description from source map: Cerro Summit Quadrangle

Qpa - Pediment deposits, pediment remnant (Pleistocene)

(0-50 ft.) Poorly sorted and rounded alluvium and colluvium. Rock types similar to Qpb. Upper few feet strongly cemented by caliche. Description from source map: Cerro Summit Quadrangle

Qpb - Pediment deposits, highest pediment remnant (Pleistocene)

(0-50 ft) Poorly sorted and rounded alluvium and colluvium about 180 feet above Qpa. Rocks include sedimentary and igneous types from Cretaceous and Tertiary formations in adjacent area to east. Upper few feet strongly cemented by caliche. Queried outcrops at south end of Shinn Park are

surfaces cut on valley-fill deposits of Bostwick-Shinn Park. Description from source map: Cerro Summit Quadrangle

Qst1 - Stream terrace alluvium, younger (upper Pleistocene)

Qt1 - Alluvial Deposits, Stream terrace alluvium (upper Pleistocene)
Sand, silt, clay, and gravel in terraces above flood plains; terrace 0-6 m (0-20 ft.) above the Qt0 terrace with the height of the terrace diminishing downstream. This terrace correlates with the Qt1 terrace mapped on the adjacent Almont quadrangle (Coogan and others, 2005). Two charcoal samples taken from the Wilson Pit gravel quarry (Section 4 T. 50 N. R. 1 E.) have yielded C14 ages of 47.7 ± 1.2 Ka before present and 49.1 ± 1.5 Ka before present (WSC unpublished data) for sediments preserved in the Qt1 terrace. Depth of the samples is hard to determine because of the quarrying operation; however, the first sample was from the base of the reddish B horizon (?) 10 cm below the disturbed surface. The second sample was taken 15 m west of the first sample, 1.5 m below the base of the B horizon. Description from source map: Gunnison Quadrangle

Qtu1 - Terrace and pediment deposits graded to former base levels of the Uncompahgre River (Pleistocene)

Poorly sorted gravels containing many cobbles and boulders of volcanic provenance, especially welded tuff. Thickness (of Qtu1, Qtu2 and Qtu3) highly varied but mostly <40 feet. Of Wisconsinan Age; mostly sandy silt. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qta1 - Terrace and pediment deposits along Alkali Creek, Onion Valley, and Crystal Creek (Pleistocene)

Poorly sorted gravels derived mainly from terranes of West Elk Breccia. Thickness (of Qta1 and Qta2) variable, commonly <20 feet. Of Wisconsinan Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qt1 - Terrace deposits of Cimarron and Blue Creek drainages, youngest (Pleistocene)

Mostly well-rounded but poorly sorted gravels of volcanic provenance. Commonly 5-20 feet thick (Qt1, Qt2, Qt3 and Qt4). Of Wisconsinan Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qt2 - Terrace deposits of Cimarron and Blue Creek drainages, younger (Pleistocene)

Mostly well-rounded but poorly sorted gravels of volcanic provenance. Commonly 5-20 feet thick (Qt1, Qt2, Qt3 and Qt4). Of Wisconsinan Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qtu2 - Terrace and pediment deposits graded to former base levels of the Uncompahgre River of pre-Wisconsinan(?) age (Pleistocene)

Poorly sorted gravels containing many cobbles and boulders of volcanic provenance, especially welded tuff. Thickness (of Qtu1, Qtu2 and Qtu3) highly varied but mostly <40 feet. Of pre-Wisconsinan (?) age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qta2 - Terrace and pediment deposits along Alkali Creek, Onion Valley, and Crystal Creek of pre-Wisconsinan(?) age (Pleistocene)

Poorly sorted gravels derived mainly from terranes of West Elk Breccia. Thickness (of Qta1 and Qta2) variable, commonly <20 feet. Of pre-Wisconsinan (?) Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qt3 - Terrace deposits of Cimarron and Blue Creek drainages, older (Pleistocene)

Mostly well-rounded but poorly sorted gravels of volcanic provenance. Commonly 5-20 feet thick (Qt1, Qt2, Qt3 and Qt4). Of pre-Wisconsinan (?) Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qfo - Alluvial-fan deposits, older (upper and middle? Pleistocene)

Qfo - Alluvial Deposits, Alluvial-fan deposits (upper and middle? Pleistocene)
Mostly poorly stratified and poorly sorted sand, silt, and gravel deposited mainly by a combination of debris flow and alluvial processes at the mouths of drainages; generally less than 12 m (40 ft.) thick. Pleistocene alluvial-fan deposits are incised and are graded to Pleistocene alluvial terraces. Description from source map: Gunnison Quadrangle

Qt - Terrace deposits, undifferentiated (Kansan(?) or older) (Pleistocene)

Gravelly deposits or remnants of deposits at varied levels, chiefly along Gunnison River near Lake Fork, Soap Creek, and West Elk Creek. Upper terrace deposit near mouth of Lake Fork is overlain by volcanic ash petrographically like Pearlette Ash Member of the Sappa Formation (late Kansan). Commonly 10-20 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qbo1 - Boulder gravel deposits, younger (Pleistocene)

Very coarse gravels containing abundant large boulders of welded tuff. Thickness (of Qbo1 and Qbo2) probably >10 feet. Of pre-Wisconsinan Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qtu3 - Terrace and pediment deposits graded to former base levels of the Uncompahgre River (Pleistocene)

Poorly sorted gravels containing many cobbles and boulders of volcanic provenance, especially welded tuff. Thickness (of Qtu1, Qtu2 and Qtu3) highly varied but mostly <40 feet. Of pre-Wisconsinan age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qt4 - Terrace deposits of Cimarron and Blue Creek drainages, oldest (Pleistocene)

Mostly well-rounded but poorly sorted gravels of volcanic provenance. Commonly 5-20 feet thick (Qt1, Qt2, Qt3 and Qt4). Of pre-Wisconsinan Age. Description from source map: Black Canyon of the Gunnison River and Vicinity

Qbo2 - Boulder gravel deposits, older (Pleistocene)

Very coarse gravels containing abundant large boulders of welded tuff. Thickness (of Qbo1 and Qbo2) probably >10 feet. Of pre-Wisconsinan Age; contains volcanic ash similar to Pearlette Ash Member of the Sappa Formation (late Kansan). Description from source map: Black Canyon of the Gunnison River and Vicinity

Qst2 - Stream terrace alluvium, older (middle? Pleistocene)

Qt2 - Alluvial Deposits, Stream terrace alluvium (middle? Pleistocene)
Sand, silt, clay, and gravel in terraces above flood plains: terrace 0-6 m (0-20 ft.) above the Qt1 terrace. This terrace is exposed in two areas that are tentatively correlated by height above the current flood plain. In the Antelope Creek drainage this unit consists of a mix of terrace and fan gravels that produce a conspicuous bench perched on bedrock above the modern alluvium. Description from source map: Gunnison Quadrangle

Qlso - Mass-movement deposits, older (Pleistocene?)

Qlso - Mass-Wasting Deposits, Mass-movement deposits (Pleistocene?)
Older slides, slumps, and flows whose surface has been reworked by fluvial and eolian process but still exhibit hummocky internal morphology; originate in clay-rich bedrock of the Cretaceous Mancos Shale and Jurassic Brushy Basin Member of the Morrison Formation; these deposits have been cut into by the Holocene flood plain; up to 20 m (65 ft.) thick. Description from source map: Gunnison Quadrangle

Qtg - Terrace gravels (Pleistocene?)

Chiefly rounded cobbles of diverse Precambrian rocks and Tertiary andesite. At least two terraces are recognized along Cebolla Creek-a younger terrace about 40 feet above stream level at an elevation of about 8,040 feet and an older terrace at an elevation of 8,240 feet. Description from source map: Powderhorn Quadrangle

Qsg - Older stream gravel of Shinn Park (Pleistocene)

Qsg - Older stream gravel, and Older stream gravel of Shinn Park (Pleistocene)
(20-30 ft.) Well-rounded coarse alluvium, boulders as large as 4 ft. Rock types are mostly volcanic porphyries. Caps hills above valley-fill deposits of Bostwick-Shinn Park. Description from source map: Cerro Summit Quadrangle

Qtb - Terrace and alluvial fan deposits in Bostwick Park and vicinity (Pleistoecene)

Poorly sorted gravel, sand, and silt, in park boundary, at 2 or more levels of deposition. Boulders of welded tuff abundant west of Bostwick Park, lacking east. Commonly 10-20 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

QTb - Boulder gravel deposits along west margin of Bostwick Park (Pleistocene or Pliocene)

QTb - Boulder gravel deposits along west margin of Bostwick Park (Pliocene or Pleistocene)
Heterogeneous mixtures of very large boulders, cobbles, pebbles, and sand. Largest boulders exceed 12 feet across. Boulders mostly welded tuff but include vesicular basalt, various intermediate felsites, intrusive porphyry, melaphyre, conglomerate, quartzite, and greenstone. Thickness undetermined but probably >20 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

QTgd - Gravel deposits (Pleistocene or Pliocene)

QTg - High level gravel remnants along rims of Black Canyon, adjacent mesas, and ancestral drainage of Grizzly Gulch (Pliocene or Pleistocene)
Along Black Canyon, derived chiefly from volcanic and Precambrian terranes; along Grizzly Gulch from West Elk Breccia. At least 2 levels of deposits. On rim west of Red Rock Canyon, gravels contain large boulders of welded tuff. Deposits on Fitzpatrick and Blue Mesas might be older than Hinsdale Formation. Thickness highly variable; locally >50 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

QTg - Gravel along Pool Gulch (Pliocene or Pleistocene)
(0-100 ft.) Well-rounded alluvial stream gravel. Rock types are mostly cobbles of volcanic porphyries. In part, similar to rock types in Tc. Some angular volcanic boulders. Deposit poorly exposed.> Description from source map: Cerro Summit Quadrangle

QTg - Quaternary and Tertiary Deposits, Gravel deposits (lower Pleistocene? to Pliocene?)
Sub-rounded to rounded unconsolidated deposits of sand, gravel and boulders (up to 25 cm) size; boulders and cobbles include Precambrian granites and metamorphic rocks, Paleozoic and Mesozoic sandstones, and Tertiary volcanics; forms a conspicuous channel to the west of Antelope Creek that is 60 to 105 m (200 to 350 ft.) above the current flood plain; 0-25 m (0-80 ft.) thick. Description from source map: Gunnison Quadrangle

QTl - Older landslide deposit on Waterdog Peak (Pleistocene or Pliocene)

QTl - Older landslide deposits on Waterdog Peak (Pliocene or Pleistocene)
(100±feet) Unstratified heterogeneous mixture of materials derived from Upper Cretaceous and

Tertiary formations present in adjacent area to south. Description from source map: Cerro Summit Quadrangle

Tc - Conglomerate on Poverty Mesa (Tertiary)

Tc - Conglomerate on Poverty Mesa (Tertiary)[1]
(75± feet) Weakly cemented coarse conglomerate comprised of various sedimentary, granitic, porphyritic, volcanic, and metamorphic rock types derived from Precambrian and younger sources. Locally underlain by green to gray tuff breccia. Deposit poorly exposed.

[1] All of conglomerate on Poverty Mesa and most of landslide deposits mapped as glacial till by Atwood and Mather, 1932, *Physiography and Quaternary geology of the San Juan Mountains, Colorado*: U.S. Geological Survey Professional Paper 166. Detailed studies indicate an origin other than glacial for these deposits.

Description and note from source map: Cerro Summit Quadrangle

Hinsdale Formation

Th - Hinsdale Formation, latite to basalt (Miocene)

Th - Hinsdale Formation, latite to basalt flows (Pliocene and Miocene)
Dark bluish gray, aphanitic to porphyritic, vesicular and scoriaceous; phenocrysts of labradorite, augite and olivine in a subophitic matrix of feldspar microlites and some magnetite. Tops of flows are commonly reddened, scoriaceous, and weathered to rubbly surfaces; bases of flows are commonly aphanitic, gray, and platy. Description from source map: Big Mesa Quadrangle

Th - Hinsdale Formation (Upper Tertiary)
Medium- to dark-gray aphanitic slightly vesicular to scoriaceous intermediate (dacite) flow remnants containing scattered phenocrysts of labradorite, augite, and olivine in a subophitic matrix of microlites and irregular grains of magnetite. Contains 3.6 percent modal quartz, 22.5 percent modal orthoclase, and 50.7 percent modal plagioclase. Maximum thickness about 150 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

Th - Hinsdale Formation, latite to basalt (Miocene and Pliocene)
Dark-gray, aphanitic to porphyritic, vesicular, scoriaceous latite to basalt; phenocrysts of labradorite or andesine, augite, and olivine in a subophitic matrix of andesine and sanidine microlites and some magnetite. In southeastern part of quadrangle, the Hinsdale occurs as two flows: an upper, porphyritic flow about 120 feet thick, and a lower, nonporphyritic flow about 40 feet thick. The flow tops are commonly reddened, scoriaceous, and weathered to rubbly surfaces and the bases of the flows are commonly dense, gray, and platy. Description from source map: Carpenter Ridge Quadrangle

Th - Hinsdale Formation, latite to basalt (Miocene and Pliocene)
Dark-gray, aphanitic to porphyritic, vesicular, scoriaceous latite to basalt; phenocrysts of labradorite, augite, and olivine in a sub-ophitic matrix of microlites and some magnetite; flows locally have a reddened, ropy base. Three small erosional remnants, as much as 60 feet thick in southern half of quadrangle, remain of formerly extensive flows. Description from source map: Gateview Quadrangle

Th - Hinsdale Formation, latitic to basaltic flows (Upper Tertiary)
Dark-gray, aphanitic to porphyritic, vesicular, scoriaceous flows; phenocrysts of labradorite or andesine, augite, and olivine in subophitic matrix of andesine and sanidine microlites and some magnetite. The flow tops are commonly reddened, scoriaceous, and weathered to rubbly surfaces, and the bases of the flows are commonly aphanitic, gray, and platy. Maximum thickness about 200

feet. Description from source map: Powderhorn Quadrangle

Thg - Hinsdale Formation, coarse gravel (Miocene)

Thg - Hindsdale Formation, gravel (Miocene and Pliocene)
Angular to rounded cobbles and boulders consisting chiefly of
Mesozoic quartzitic sandstone and conglomerate and smaller amounts of granite, diverse Precambrian rocks, and sparse Tertiary volcanic rocks. Commonly 5 to 40 feet thick. Description from source map: Big Mesa Quadrangle

Thg - Hinsdale Formation, coarse gravel (Miocene and Pliocene)
Contains cobbles and boulders of Mesozoic quartzitic sandstone and conglomerate and smaller amounts of granite, other Precambrian rocks, and Tertiary volcanic rocks. In places, the paucity of boulders of Tertiary volcanic rocks suggests deposition, on the underlying tuffs, from nearby higher terranes of pre-Tertiary rocks. Commonly 5-40 feet thick. Description from source map: Carpenter Ridge Quadrangle

Thg - Hinsdale Formation, coarse subrounded gravel (Miocene and Pliocene)
Thin gravel containing angular to rounded boulders and cobbles of diverse Precambrian igneous, sedimentary, and metamorphic rocks, and Cenozoic igneous rocks. Generally less than 5 feet thick. Includes a small area in sec. 6, T.46N., R.2W., of post-Fish Canyon gravels of uncertain age. Description from source map: Gateview Quadrangle

Thg - Hinsdale Formation, coarse gravel (Miocene)
Cobbles and boulders consisting of Mesozoic quartzitic sandstone and conglomerate and smaller amount of granite, other Precambrian rocks, and very minor Tertiary volcanic rock. Discontinuous gravel deposits at base of Hinsdale. Less than 10 feet thick. Description from source map: Powderhorn Quadrangle

Gravel of MacIntosh Mountain

Tmvg - Gravel of MacIntosh Mountain, volcanic gravel (Oligocene)

Alluvial gravels that consist of pebbles, cobbles, and boulders of andesitic and dacitic lavas. Epiclasts are rounded to subrounded and were deposited in streams that drained the eroding surface of West Elk Volcano Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Tmpg - Gravel of MacIntosh Mountain, Precambrian-bearing gravels (Oligocene)

Discontinuous coarse gravels containing pebbles, cobbles, and boulders of various Precambrian plutonic and metamophic rocks, Paleozoic limestones and sandstones, and Mesozoic sandstones. Some horizons contain larger 2-3 meter boulders of polished densely welded Sapinero Mesa Tuff in a gravel matrix. Description from source map: McIntosh Mountain Quadrangle

Tcav - Calcite veins (Oligocene)

cv - Calcite veins (Oligocene)
Calcite veins with fracture-fillings and replacement veins of manganese oxides 0.8 mile east of

Spencer; veins strike N.45°-80° W., are 3-12 feet thick, and can be traced about 600 feet; locally contain abundant fragments of Mesozoic quartzite and siltstone and sparse Tertiary volcanic fragments. Description from source map: Powderhorn Quadrangle

Tgb - Gravel, breccia and sand deposits (Oligocene)

Tgb - Tertiary Sediments, Gravel, breccia, and sand deposits (Oligocene)
This unit is composed of sub-angular to sub-rounded unconsolidated gravels and breccias with interbedded coarse sands. Deposits contain sediment from sand to boulder (up to 15 cm) size. Boulders and cobbles include Tertiary volcanics, Precambrian tonalite and granodiorite, and metamorphic rocks such as amphibolite, biotite quarzite, and biotite-quartz gneiss. These clasts are consistent with a provenance in the Gunnison Gold Belt to the south. These deposits occupy channels at several stratigraphic horizons: between the bedded tuffs of East Elk Creek and the Fish Canyon Tuff (0-40 m; 0-130 ft thick), between the Sapinero Mesa and Fish Canyon Tuffs (0-25m; 0-80 ft. thick), and between the Fish Canyon and Carpenter Ridge Tuffs (0-60m; 0-200 ft. thick). Gravels not capped by Oligocene tuffs may be younger (Miocene to Pliocene) if deposited in channels that were later eroded though all the tuffs. Description from source map: Gunnison Quadrangle

Tg - Tertiary gravel deposits (Oligocene)

Tg - Tertiary Sediments, Gravel deposits (Oligocene)
This unit is composed of sub-rounded to rounded unconsolidated river gravels. Gravel deposits contain sediment from sand to boulder (up to 50 cm) size. Boulders and cobbles include Precambrian granites and metamorphic rocks, Paleozoic and Mesozoic sandstones, and Tertiary volcanics. Extensive gravel deposits continue to the south and east (Olson, 1976a,b). These clasts are consistent with a provenance to the east and were deposited in Oligocene drainages that had headwaters near the current position of the Continental Divide (Gregory and Chase, 1994). These gravels mark various positions of paleo-Tomichi Creek as it was disrupted by Oligocene volcanism. These gravels overlie the West Elk Breccia and intertongue with the Blue Mesa, Sapinero Mesa, Fish Canyon, and Carpenter Ridge Tuffs. The deposits are 0-75m (0-250 ft.) thick. Description from source map: Gunnison Quadrangle

Tlg - Tuff of Long Gultch (Oligocene)

Light-brownish-gray, moderately welded, devitrified ash-flow tuff: contains about 8 percent phenocrysts; fragmented phenocrysts consist of the following, in percent: calcic oligoclase 43, sanidine 37, quartz 20, and less than 1 percent biotite; has more sanidine and less biotite than other phenocryst-poor tuffs to northwest. Erosional remnant has thickness of about 140 feet in southeast corner of map. May be correlative with Nelson Mountain Tuff (Steven and Ratte, 1964, p. 61; 1973). Description from source map: Iris NW Quadrangle

Tr - Rat Creek(?) Tuff (Oligocene)

Very light gray, nonwelded, vitric tuff; fragmented phenocrysts compose 16-25 percent of rock and consist of 1-10 percent alkali feldspar, 62-84 percent andesine, 9-11 percent quartz, 6-12 percent biotite, and 0-5 percent hornblende; unit is dominantly airfall tuff but contains some interbeds rich in coarse angular fragments of Precambrian rock and Mesozoic sandstone. Correlation with Rat Creek Tuff (Steven and Ratte, 1964, p. 60-61; 1973) is uncertain. Unit is as much as 350 feet thick. Description from source map: Iris NW Quadrangle

Tcu - Carpenter Ridge Tuff, undivided (Oligocene)

Tcr - Carpenter Ridge Tuff (Oligocene)
Very light gray platy devitrified welded or partly welded tuff; at the base, dark-brown vitrophyre. Contains scattered phenocrysts of plagioclase, sanidine, biotite, magnetite, oxyhornblende, and sparse clinopyroxene. In places, a compound cooling unit, indicated by gravel, non-welded tuff, or brown vitrophyre (UV) at the base of the upper ash flow. Maximum thickness about 220 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

Unit mapped as Tc, Tcn and Tcv.
Composite ash-flow about 240 feet thick at its type locality on Carpenter Ridge in south-central part of quadrangle. Description from source map: Carpenter Ridge Quadrangle

Unit mapped as Tc, Tcv and Tcn.
Composite formation composed of at least two ash flows. As much as 250 feet thick. Description from source map: Gateview Quadrangle

Tc - Tertiary Volcanic Deposits, Carpenter Ridge Tuff (Oligocene)
The Carpenter Ridge Tuff is a red-brown densely to partly welded rhyolitic ash flow tuff containing 2-5% phenocrysts of plagioclase, sanidine, and biotite. The partly welded tuff has conspicuous pumice fragments (up to 4 cm). Lipman (2000) recommends an age of 27.35 MA for this tuff; modified to 27.55 Ma based on a new Ar/Ar calibration that dates the Fish Canyon Tuff at 28.04 Ma (Lipman, personal communication 2006). The Carpenter Ridge Tuff has a maximum preserved thickness of 50 m (160 ft). Description from source map: Gunnison Quadrangle

Tcb - Carpenter Ridge Tuff, tuffaceous breccia (Oligocene)

Abundant fragments of Mesozoic quartzite and various Precambrian rocks in a matrix on nonwelded tuff; largely represented by lag gravels. Minimum thickness of 60 feet. Description from source map: Big Mesa Quadrangle

Tca - Carpenter Ridge Tuff, ash-flow tuff (Oligocene)

Tc - Carpenter Ridge Tuff, ash flow tuff (Oligocene)
Reddish-brown, devitrified, and strongly welded; contains 5-10 percent phenocrysts of oligoclase-andesine (An 25-35), sanidine, biotite, magnetite, oxyhornblende, and sparse clinopyroxene. Occurs in middle of Carpenter Ridge Tuff as a layer 20-160 feet thick and as a discontinuous ash-flow unit, as much as 120 feet thick, underlying the Tcn unit. Vitrophyre less than 10 feet thick occurs discontinuously at base of lowermost Tc unit. Description from source map: Big Mesa Quadrangle

Tc - Carpenter Ridge Tuff, devitrified, welded or partially welded tuff (Oligocene)
Light-gray, platy tuff containing 5-10 percent phenocrysts of oligoclase-andesine (An_{25-35}), sanidine, biotite, magnetite, oxyhornblende, and sparse clinopyroxene. Commonly 20-200 feet thick. Description from source map: Carpenter Ridge Quadrangle

Tc - Carpenter Ridge Tuff, devitrified welded or partially welded tuff (Oligocene)
Light-gray, platy tuff containing phenocrysts of oligoclase-andesine (An 25-35), sanidine, biotite, magnetite, oxyhornblende, and sparse clinopyroxene. Hollow lithoshysae locally abundant in upper part of unit. 20-200 feet thick. Description from source map: Gateview Quadrangle

Tc -Carpenter Ridge Tuff, ash-flow tuff (Oligocene)
Light pinkish-brown to gray devitrified densely to partially welded vitric lapilli ash tuff; contains 5-10 percent phenocrysts of plagioclase, sanidine, biotite, magnetite, oxyhornblende, and sparse clinopyroxene. Description from source maps: Little Soap Park Quadrangle and: McIntosh Mountain Quadrangle

Tc - Carpenter Ridge Tuff, ash-flow tuff (Oligocene)
Reddish-brown to brownish-gray, densely welded tuff composed of devitrified ash shards, compacted pumice lapilli, about 10 percent fragmented phenocrysts of calcic oligoclase and sodic andesine (An 32-35), and very minor sanidine, biotite, oxyhornblende, magnetite, and clinopyroxene; hollow lithophysae locally abundant. About 160 feet thick in southwest corner of quadrangle. Description from source map: Powderhorn Quadrangle

Tcv - Carpenter Ridge Tuff, dark-brown to black vitrophyre (Oligocene)

UV - Carpender Ridge Tuff, brown vitrophyre (Oligocene)
At the base of the upper ash flow. Description from source map: Black Canyon of the Gunnison River and Vicinity

Tcv - Carpenter Ridge Tuff, dark-brown to black vitrophyre (Oligocene)
No additional description provided on source map. Unit present on source map: Carpenter Ridge Quadrangle

Tcv - Carpenter Ridge Tuff, dark-brown to black vitrophyre (Oligocene)
No additional description provided on source map. Unit present on source map: Gateview Quadrangle

Tcv - Carpenter Ridge Tuff, vitrophyre (Oligocene)
Light gray to dark-gray densely-welded vitric lapilli-ash tuff. Vitrophyres occur discontinuously at two levels in the Carpenter Ridge Tuff, separated by a pinkish devitrified densely welded layer. The basal vitrophyre is up to 10 meters thick and is only found in the southwest part of the McIntosh Mnt. quadrangle. Where well exposed, the basal vitrophyre is underlain by 2 meters of unwelded pumice-rich lapilli ash tuff. The upper vitrophyre is found in the same area but is poorly exposed and not mapped as a separate unit. Description from source map: McIntosh Mountain Quadrangle

Tcn - Carpenter Ridge Tuff, nonwelded ash-flow tuff (Oligocene)

Tcn - Carpenter Ridge Tuff, nonwelded pumiceous tuff (Oligocene)
White to light-reddish-brown, coarse-grained, typically soft, friable, and easily eroded tuff; chiefly an air-fall tuff; local stratification and sparse crossbedding suggest some reworking by streams; contains white pumice fragments as much as 8 inches long and about 5 percent crystal fragments of oligoclase-andesite (An 28-37), sparse biotite, and sparse green clinopyroxene; fragments of various Precambrian rocks are locally abundant in the tuff. About 160 feet thick at Blaine Rock. Description from source map: Big Mesa Quadrangle

Tcn - Carpenter Ridge Tuff, nonwelded pumiceous tuff (Oligocene)
Composition generally similar to Tc unit: typically, soft, friable, easily eroded. Upper and basal parts locally contain lenses of angular fragments of Precambrian rocks and Mesozoic quartzitic sandstone. In part, represents, an airfall tuff; local stratification and sparse crossbedding suggest some reworking by streams. Vertical calcite-rich pipes 6-12 inches in diameter found in nonwelded tuff atop hill west of Kezar Basin may represent fossil fumaroles. As much as 160 feet thick. Description from source map: Carpenter Ridge Quadrangle

Tcn - Carpenter Ridge Tuff, nonwelded pumiceous tuff (Oligocene)

Generally similar to Tc unit in composition. Description from source map: Gateview Quadrangle

Tcn - Carpenter Ridge Tuff, nonwelded pumiceous tuff (Oligocene)
Very light gray, typically soft, friable, and easily eroded tuff; upper part largely represents an air-fall tuff that shows stratification and sparse cross-bedding, which suggests some reworking by streams; lower zone is a poorly welded, vitric ash-flow tuff that is transitional to a densely welded zone. As much as 160 feet thick. Description from source map: Powderhorn Quadrangle

Tcvg - Carpenter Ridge Tuff, volcanic gravels (Oligocene)

These are alluvial gravels and conglomerates that consist of pebbles, cobbles, and boulders of andesitic and dacitic lavas. Epiclasts are rounded to subrounded and were deposited in streams that drained the eroding surface of West Elk Volcano. Description from source map: McIntosh Mountain Quadrangle

Tfu - Fish Canyon Tuff, undivided (Oligocene)

Tfc - Fish Canyon Tuff (Oligocene)
Light-gray crystal-rich (<45 percent) loosely welded tuff containing predominant fragmented crystals of plagioclase and subordinate sanidine, biotite, quartz, oxyhornblende, and sparse pale-green clinopyroxene. A potassium-argon radiometric age of 27+/-3 million years was obtained from biotite separated from a sample collected on Sapinero Mesa$_1$. Maximum thickness about 300 feet.

Description from source map: Black Canyon of the Gunnison River and Vicinity

Tf - Fish Canyon Tuff (Oligocene)
Ash-flow deposit of light-gray to white, crystal-rich welded tuff grading upward into non-welded pumiceous tuff. Contains 30-45 percent fragmented crystals of zoned sodic andesine and calcic oligoclase, with subordinate sanidine, coarse-grained biotite, quartz, oxyhornblende, and sparse sphene, iron oxides, and pale-green clinopyroxene. Typically weathers to rounded, pedestal, and beehive forms. Upper part is concretionary in a few places. About 300 feet thick, both welded and nonwelded portions are commonly 100-200 feet thick. Description from source map: Carpenter Ridge Quadrangle

Tf - Tertiary Volcanic Deposits, Fish Canyon Tuff (Oligocene)
The Fish Canyon Tuff is a light-gray nonwelded to dark-gray-brown densely welded dacitic ash flow tuff. The tuff contains 35-40% phenocrysts of plagioclase, sanidine, biotite and hornblende, with lesser amounts of quartz and titanite. The base of the tuff contains abundant angular lithic fragments (~1 to 5 cm) of locally derived Precambrian schists, quartzites, and amphibolites. As the tuff weathers, these lithic fragments produce a distinctive colluvial lag deposit at the base of the tuff. Lipman (2000) recommends an age of 27.6 Ma for this unit; modified to 28.04 Ma based on a new Ar/Ar calibration (Lipman, personal communication 2006). . The Fish Canyon Tuff has a maximum preserved thickness of 85 m (280 ft). Description from source map: Gunnison Quadrangle

Tf - Fish Canyon Tuff (Oligocene)
Very light gray to light-brownish-gray tuff, welded except at base, devitrified; contains 25-35 percent phenocrysts of calcic oligoclase, sanidine, and quartz, and about 3 percent biotite; silicified concretions are locally abundant at upper contact. Unit is as much as 300 feet thick. Description from source map: Iris NW Quadrangle

Tfa - Fish Canyon Tuff, ash-flow tuff (Oligocene)

Tf - Fish Canyon Tuff, ash-flow tuff (Oligocene)
Light-gray to light-pinkish-gray; contains 30-45 percent fragments of zoned andesine and calcic oligoclase crystals, minor sanidine, and distinctive coarse-grained biotite in a devitrified groundmass of welded ash shards and pumice lapilli; typically weathers to rounded pedestal and beehive forms. As much as 400 feet thick. Description from source map: Big Mesa Quadrangle

Tf - Fish Canyon Tuff, crystal-rich welded tuff (Oligocene)
Ash-flow deposits composed chiefly of light-gray to white, crystal-rich welded tuff; becomes less welded near top. Contains 30-45 percent fragmented crystals of zoned sodic andesine and calcic oligoclase, with subordinate sanidine, coarse-grained biotite, quartz, oxyhornblende, and sparse sphene, iron oxides, and pale-green clinopyroxene. Locally has foliation due chiefly to alignment of biotite flakes. As much as 450 feet thick. Description from source map: Gateview Quadrangle

Tf – Fish Canyon Tuff, ash-flow tuff (Oligocene)
Light gray to light-pinkish-gray moderately-welded crystal vitric lapilli ash tuff; contains 30-45 percent fragments of plagioclase and distinctive abundant biotite; contains minor amounts of sanidine, iron oxides and clinopyroxene. Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Tf - Fish Canyon Tuff, ash-flow tuff (Oligocene)
Light-gray to light-pinkish-gray tuff; massive to foliated; weathers to rounded, pedestal, and beehive forms; crystal-rich and strongly welded containing devitrified shards and collapsed pumice lapilli; about 35 percent fragmented phenocrysts of zoned calcic oligoclase and sodic andesine; subordinate amounts of biotite, sanidine, and quartz with accessory sphene, magnetite, and pale-green clinopyroxene. Maximum thickness about 640 feet. Description from source map: Powderhorn Quadrangle

Tfn - Fish Canyon Tuff, nonwelded ash-flow tuff (Oligocene)

Tfn - Fish Canyon Tuff, non-welded ash-flow tuff (Oligocene)
Light-gray; grades into densely welded crystal-rich ash-flow tuff (Tf); distinguishable from the Dillon Mesa Tuff by the abundance of fragmented crystals. Crops out in small areas in the south-central part of the quadrangle. Description from source map: Big Mesa Quadrangle

Tfv - Fish Canyon Tuff, vitric tuff (Oligocene)

Tfv - Fish Canyon Tuff, thin vitric tuff (Oligocene)
Contains numerous black shards and some glassy pumice fragments; locally present in southeastern part of quadrangle. Description from source map: Gateview Quadrangle

Tfv - Fish Canyon Tuff, vitric tuff (Oligocene)
Similar in composition to overlying Tf unit, but contains numerous black vitric shards and some glassy pumice fragments. Locally present; as much as a few feet in thickness in southwest corner of quadrangle. Description from source map: Powderhorn Quadrangle

Tfg - Fish Canyon Tuff, coarse gravel (Oligocene)

Tfg - Fish Canyon Tuff, coarse gravel (Oligocene)
In places, areas mapped as Tfg may represent residuum from the weathering of Tfn unit; in isolated outcrops gravel deposits indistinguishable from those below the Sapinero Mesa Tuff; in such areas

gravel deposits are mapped as Tfg on basis of proximity to the other Fish Canyon Tuff units. Locally 20 feet or more thick at the base of the Fish Canyon Tuff. Description from source map: Big Mesa Quadrangle

Tfg - Fish Canyon Tuff, tuffaceous gravel (Oligocene)
Gravel contains rounded boulders and cobbles of various Tertiary, Mesozoic, and Precambrian rocks. Unit includes nonwelded tuff and is locally present west of the Lake Fork Gunnison River. As much as 100 feet thick. Description from source map: Gateview Quadrangle

Tfpg - Fish Canyon Tuff, Precambrian-bearing gravels (Oligocene)
Discontinuous coarse gravels containing pebbles and cobbles of various Precambrian plutonic and metamophic rocks, Paleozoic and Mesozoic sandstones. This unit is equivalent to the Tfg of Hedlund (1974). Description from source map: McIntosh Mountain Quadrangle

Tfvg - Fish Canyon Tuff, volcanic gravels (Oligocene)

These are alluvial gravels and conglomerates that consist of pebbles, cobbles, and boulders of andesitic and dacitic lavas. Epiclasts are rounded to subrounded and were deposited in streams that drained the eroding surface of West Elk Volcano. Description from source map: McIntosh Mountain Quadrangle

Tsmu - Sapinero Mesa Tuff, undivided (Oligocene)

Tsm - Sapinero Mesa Tuff, devitrified welded tuff (Tertiary)
Mostly reddish-brown devitrified welded tuff grading upward into non-welded tuff, containing scattered phenocrysts of plagioclase (predominant), sanidine, biotite, and sparse oxyhornblende and clinopyroxene; abundant collapsed pumice. At the base, black vitrophyre 20-50 feet thick containing abundant reddish-brown spherulites, commonly underlain by gravel. Thickness commonly about 80-180 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

Ts - Tertiary Volcanic Deposits, Sapinero Mesa Tuff (Oligocene)
The Sapinero Mesa Tuff is a gray nonwelded to red- brown densely welded rhyolitic ash flow tuff containing 2-5% phenocrysts of plagioclase, sanidine, and biotite. In the scattered outcrops, welding decreases from west to east with red-brown densely welded devitrified tuff preserved in the far southwest, dark-gray partially welded tuff beneath Tenderfoot Mountain, and nonwelded pumiceous ash interbedded with gravels to the east of Tenderfoot Mountain. The partially welded tuffs have conspicuous 1-2 cm light-gray pumice fragments. Bove and others (2001) report an average sanidine Ar/Ar age of 28.19 ± .06 Ma. The Sapinero Mesa Tuff has a maximum preserved thickness of 15 m (50 ft). Description from source map: Gunnison Quadrangle

Tsma - Sapinero Mesa Tuff, ash-flow tuff (Oligocene)

Ts - Sapinero Mesa Tuff, ash-flow tuff (Oligocene)
Reddish-brown, devitrified, welded tuff containing about 10 percent crystal fragments in a groundmass of welded ash shards and pumice lapilli. The crystals are of zoned oligoclase-andesine (An 28-32), and less than one percent biotite, quartz, oxyhornblende, and iron oxides. Hollow lithophysae are locally abundant. Occurs discontinuously, chiefly along Willow Creek. As much as 200 feet thick. Description from source map: Big Mesa Quadrangle

Ts - Sapinero Mesa Tuff, devitrified welded tuff (Oligocene)
Reddish-brown to light-brownish-gray tuff containing 5-12 percent phenocrysts which are composed of andesine-calcic oligocene (An 23-35), lesser amounts of sanidine, quartz, and biotite, and sparse

oxyhornblende and clinopyrozene. As much as 100 feet thick. Description from source map: Carpenter Ridge Quadrangle

Ts - Sapinero Mesa Tuff, devitrified welded tuff (Oligocene)
Reddish-brown to light-brownish-gray, contains 5-12 percent phenocrysts which are composed of andesine and calcic oligoclase (An 23-35), lesser amounts of sanidine, quartz, and biotite, and sparse oxyhornblende and clinopyroxene. Hollow lithophysae locally abundant. As much as 220 feet thick. Description from source map: Gateview Quadrangle

Ts - Sapinero Mesa Tuff, ash-flow tuff (Oligocene)
Light-brownish-gray, pale-red or light-brown, densely welded, devitrified tuff; locally has vitric base; 5-12 percent phenocrysts of calcic oligoclase, sanidine, quartz, and biotite. As much as 200 feet thick. Description from source map: Iris NW Quadrangle

Ts – Sapinero Mesa Tuff, ash-flow tuff (Oligocene)
Reddish-brown to grey devitrified densely welded vitric lapilli ash tuff; contains 5-12 percent phenocrysts of plagioclase with minor sanidine, biotite, quartz, oxyhornblende, clinopyroxene, and iron oxides. Hollow lithophysae with a white rim are dispersed throughout the unit and are locally abundant. Large pumice fragments (up to 5-10 cm) are present in some areas. Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Ts - Sapinero Mesa Tuff, ash-flow tuff (Oligocene)
Reddish-brown to light-brownish gray, strongly welded and devitrified tuff (Olson and others, 1968, p. 19-20) containing 5-12 percent fragmented phenocrysts which are composed of sodic andesine and calcic oligoclase (An 23-45), lesser amounts of sanidine, quartz, biotite, and sparse oxyhornblende and clinopyroxene; hollow lithophysae locally present. As much as 280 feet thick. Description from source map: Powderhorn Quadrangle

Tsmn - Sapinero Mesa Tuff, nonwelded pumiceous tuff (Oligocene)

Tsn - Sapinero Mesa Tuff, nonwelded pumiceous tuff (Oligocene)
Light-gray, coarse-grained tuff; contains abundant white pumice lapilli; crystal content the same at Ts unit. Commonly less than 20 feet thick. Description from source map: Big Mesa Quadrangle

Tsn - Sapinero Mesa Tuff, nonwelded ash-flow tuff (Oligocene)
Very light gray, weakly devitrified, probably nonwelded zone of the densely welded tuff in sec. 20, T.49N., R.1W. About 45 feet thick. Description from source map: Iris NW Quadrangle

Tsmv - Sapinero Mesa Tuff, vitrophyre (Oligocene)

Tsv - Sapinero Mesa Tuff, vitrophyre (Oligocene)
Vitric welded tuff at the base of Ts unit; black; similar in composition to Ts; sharp local relief on underlying depositional surface causes irregular outcrop pattern in some areas. Commonly 10-50 feet thick. Description from source map: Big Mesa Quadrangle

Tsv - Sapinero Mesa Tuff, black vitrophyre (Oligocene)
Contains reddish-brown spherulites, hollow lithophysae, pumice fragments, and sparse fragments of Precambrian rocks and Mesozoic quartzite. Commonly 10-50 feet thick. Type locality of the Sapinero Mesa Tuff is at Tenmile Springs in southern part of quadrangle. Description from source map: Carpenter Ridge Quadrangle

Tsv - Sapinero Mesa Tuff, black vitrophyre (Oligocene)
Contains reddish-brown spherulites; commonly 10-50 feet thick. Description from source map:

Gateview Quadrangle

Tsv - Sapinero Mesa Tuff, vitrophyre (Oligocene)
Black, welded; similar in composition to Ts unit. About 50 feet thick along the south side of Sugar Creek in secs. 29 and 30, T.48N., R.1W. Description from source map: Iris NW Quadrangle

Tsv – Sapinero Mesa Tuff, vitrophyre (Oligocene)
Black to dark-grey densely welded vitric lapilli-ash tuff. Reddish- brown spherulites and hollow lithophysae are locally abundant. Large light-grey flattened pumice fragments (up to 5 cm) are usually present. Description from source map: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Tsv - Sapinero Mesa Tuff, vitric ash-flow tuff (Oligocene)
Black vitrophyre found locally beneath the Ts unit; locally contains reddish-brown spherulites. As much as 15 feet thick in Huntsman Gulch Area Description from source map: Powderhorn Quadrangle

Tsmg - Sapinero Mesa Tuff, gravel (Oligocene)

Tsg - Sapinero Mesa Tuff, gravel (Oligocene)
Thin discontinuous gravel deposits containing rounded to angular fragments of diverse Precambrian rocks and Mesozoic sandstone. Commonly less than 10 feet thick. Description from source map: Big Mesa Quadrangle

Tsg - Sapinero Mesa Tuff, gravel (Oligocene)
Contains rounded boulders and cobbles of various older rocks. Description from source map: Gateview Quadrangle

Tspg - Sapinero Mesa Tuff, Precambrian-bearing gravels (Oligocene)
Discontinuous coarse gravels containing pebbles and cobbles of various Precambrian plutonic and metamorphic rocks, Paleozoic and Mesozoic sandstones. This unit is equivalent to the Tsg of Hedlund (1974). Description from source map: McIntosh Mountain Quadrangle

Tsmvg - Sapinero Mesa Tuff, volcanic gravels (Oligocene)

No additional description provided on source map. Unit present on source map: Little Soap Park Quadrangle

Tgo - Older Tertiary gravel deposits, undifferentiated (Oligocene and older?)

Tg - Gravel deposits, undifferentiated (Oligocene and older?)
Contain boulders and cobbles of various Precambrian, Mesozoic, and Cenozoic rocks; most gravels appear older than Fish Canyon Tuff and some older than Sapinero Mesa Tuff. Thickness as much as 140 feet. Description from source map: Iris NW Quadrangle

Tdmu - Dillon Mesa Tuff, undivided (Oligocene)

Tdm - Dillon Mesa Tuff (Oligocene)
Mostly light-brown slightly porphyritic moderately welded tuff, locally with 10-20 feet of dark-brown vitrophyre at base, commonly underlain by gravel. Generally less than 80 but locally as much as 180

feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Td - Dillon Mesa Tuff (Oligocene)
Light-brown, lightly to moderately welded tuff containing phenocrysts of calcic oligoclase, sanidine, and biotite. About 35 feet thick. Description from source map: Carpenter Ridge Quadrangle

Td - Dillon Mesa Tuff (Oligocene)
No additional description provided on source map. Unit present on source map: Little Soap Park Quadrangle

Tdmb - Dillon Mesa Tuff, tuffaceous breccia (Oligocene)

Tdb - Dillon Mesa Tuff, tuffaceous breccia (Oligocene)
Discontinuous thin beds of reworked tuff containing Precambrian rocks and Mesozoic quartzite fragments in a pumiceous and tuffaceous matrix. 0-40 feet thick in the vicinity of Blaine Rock. Description from source map: Big Mesa Quadrangle

Tdmw - Dillon Mesa Tuff, nonwelded and moderately welded air-fall tuff (Oligocene)

Td - Dillon Mesa Tuff, nonwelded air-fall tuff (Oligocene)
Very light gray, pumiceous; contains about 10 percent crystal fragments and coarse blocky pumice. Maximum thickness about 80 feet two miles south of Iola; diminishes southward. Description from source map: Big Mesa Quadrangle

Td - Dillon Mesa Tuff, moderately welded tuff and soft airfall tuff (Oligocene)
Light-brown, moderately welded tuff containing scattered phenocrysts of plagioclase, sanidine, and biotite, and soft gray airfall tuff, locally bedded near top. About 40-120 feet thick. Description from source map: Gateview Quadrangle

Tdmv - Dillon Mesa Tuff, vitrophyre (Oligocene)

Tdv - Dillon Mesa Tuff, vitrophyre (Oligocene)
Locally present north of Gunnison River. Description from source map: Big Mesa Quadrangle

Tdmg - Dillon Mesa Tuff, gravel (Oligocene)

Tdg - Dillon Mesa Tuff, gravel (Oligocene)
As much as 50 feet thick. Description from source map: Gateview Quadrangle

Tdmbm - Dillon Mesa and Blue Mesa Tuffs, undivided, air-fall tuff, tuffaceous sediments, and travertine (Oligocene)

Air-fall tuff, tuffaceous sediments, and travertine. Nonwelded to weakly welded pumiceous tuff, very light gray, partly stratified; thin discontinuous travertine beds less than 2 feet thick locally present near base. As much as 150 feet thick along Huntsman Gulch. Description from source map: Powderhorn Quadrangle

Tdmbmb - Dillon Mesa and Blue Mesa Tuffs, undivided, tuff breccia (Oligocene)

Reddish-brown, angular fragments of devitrified welded tuff and reworked comminuted fragments of plagioclase and biotite phenocrysts. As much as 50 feet thick. Description from source map: Powderhorn Quadrangle

Tbmu - Blue Mesa Tuff, undivided (Oligocene)

Tbm - Blue Mesa Tuff (Oligocene)
Massive cliff-forming light-bluish-gray to pale-reddish-brown devitrified densely welded tuff containing scattered phenocrysts of plagioclase, sanidine, and biotite,rare oxyhornblende and clinopyroxene, and scattered inclusions of pumice. Partly vesicular. Grades up-ward into light-gray non-welded tuff. At the base, a few feet of white non-welded tuff overlain by 10-14 feet of black vitrophyre. Maximum thickness > 250 feet. Description from source map: Black Canyon of the Gunnison River and Vicinity

Tb - Tertiary Volcanic Deposits, Blue Mesa Tuff (Oligocene)
The Blue Mesa Tuff is a dark-gray to red-brown densely welded rhyolitic ash flow tuff containing <5% phenocrysts of plagioclase, sanidine, and biotite. This unit is only found in the far southwest corner of the map area as a black vitrophyre with conspicuous 2-3 cm pumice fiamme. Red-brown densely welded devitrified tuff is locally found above the vitrophyre. Bove and others (2001) report a sanidine Ar/Ar age of 28.40 ± .07 Ma. The Blue Mesa Tuff has a maximum preserved thickness of 9 m (30 ft). Description from source map: Gunnison Quadrangle

Tbmaw - Blue Mesa Tuff, ash-flow tuff and devitrified welded tuff (Oligocene)

Tb – Blue Mesa Tuff, ash-flow tuff (Oligocene)
Pale-reddish brown, devitrified and densely welded; about 10 percent crystal fragments of zoned oligoclase-andesine (An 28-35), and less than one percent biotite, quartz, and iron oxides; sparse oxy-hornblende and pale-green clinopyroxene. Discontinuous outcrops along both sides of the Gunnison River. 0-80 feet thick. Description from source map: Big Mesa Quadrangle

Tb - Blue Mesa Tuff, devitrified welded tuff (Oligocene)
Massive, cliff-forming, light-gray to pale-reddish-brown, devitrified, mostly densely welded tuff containing 7-15 percent phenocrysts of oligoclase-andesine (An 24-35), sanidine, biotite, and sparse clinopyroxene and oxyhornblende. Commonly 100-140 feet thick, locally reaches 200 feet. Description from source map: Carpenter Ridge Quadrangle

Tb - Blue Mesa Tuff, devitrified welded tuff (Oligocene)
Massive, cliff-forming, light-gray to pale-reddish-brown devitrified densely welded tuff containing 7-15 percent phenocrysts of oligoclase-andesine (An 23-35), sanidine, biotite, and sparse clinopyroxene and oxyhornblende. As much as 230 feet thick north of Gateview. Description from source map: Gateview Quadrangle

Tb – Blue Mesa Tuff, ash-flow tuff (Oligocene)
Reddish-brown devitrified densely-welded vitric lapilli ash tuff; contains 7-15 percent phenocrysts of plagioclase with minor sanidine, biotite, quartz, and iron oxides; sparse oxyhornblende and clinopyroxene. Description from source map: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

Tbmg - Blue Mesa Tuff, gravel (Oligocene)

Tbg - Blue Mesa Tuff, gravel (Oligocene)
Thin layer of gravel containing boulders and cobbles of various older rocks; found locally at base of tuff in Lake Fork area. Description from source map: Gateview Quadrangle

Tbmv - Blue Mesa Tuff, vitrophyre (Oligocene)

Tbv - Blue Mesa Tuff, vitrophyre (Oligocene)
Black, discontinuous welded tuff at the base of the devitrified zones. As much as 20 feet. Description from source map: Big Mesa Quadrangle

Tbv - Blue Mesa Tuff, black vitrophyre (Oligocene)
Discontinuously present at base of Tb unit and similar to it in composition. As much as 20 feet thick. Description from source map: Carpenter Ridge Quadrangle

Tbv - Blue Mesa Tuff, black vitrophyre (Oligocene)
Discontinuously present at base of Tb unit; as much as 20 feet thick; similar to Tb unit in composition. Description from source map: Gateview Quadrangle

Tbv – Blue Mesa Tuff, vitrophyre (Oligocene)
Black to dark-grey densely welded vitric lapilli-ash tuff. Description from source map: McIntosh Mountain Quadrangle

Tbmpg - Blue Mesa Tuff, Precambrian-bearing gravels (Oligocene)

Tbpg - Blue Mesa Tuff, Precambrian-bearing gravels (Oligocene)
Discontinuous coarse gravels containing pebbles and cobbles of various Precambrian plutonic and metamophic rocks, Paleozoic and Mesozoic sandstones. Description from source map: McIntosh Mountain Quadrangle

Ttsc - Talus, slope wash or colluvium, undivided (Oligocene)

Poorly sorted, incoherent, angular fragments of Precambrian granite and Mesozoic quartzite; deposited chiefly by gravity on or at the foot of a slope. As much as several feet in thickness. Description from source map: Powderhorn Quadrangle

Ttr - Travertine, older (Oligocene)

Ttr - Travertine (Oligocene)
Indurated, compact to porous, light-yellowish-gray travertine, composed mostly of aragonite; in places laminated or brecciated; plant casts locally abundant. As much as 50 feet thick. Description from source map: Powderhorn Quadrangle

Tj - Jasper or siliceous sinter (Oligocene)

Reddish-brown, black, and yellowish-brown; local laminations dip 15° to 25°. Probably represents sinter deposits generally less than 10 feet thick near extinct springs in Huntsman Gulch area.

Description from source map: Powderhorn Quadrangle

Lake Fork Formation

Tl - Lake Fork Formation, hornblende rhyodacite flows (Oligocene)

Tlr - Lake Fork Formation, rhyodacite flows (Oligocene and older?)
Light-gray, pinkish- to reddish-brown rhyodacite flows, commonly autobrecciated. Phenocrysts of andesine, oxyhornblende, and biotite are set in aphanitic groundmass; trachytic texture. As much as 900 feet thick. Description from source map: Gateview Quadrangle

Tl - Lake Fork Formation, hornblende rhyodacite flows (Oligocene)
Hornblende rhyodacite flows-Light-gray to dark-greenish-gray, and pinkish-to reddish-brown flows, locally autobrecciated, in southwest corner of quadrangle. Columnar jointing and calcite-filled vugs are common; trachytic, containing about 15 percent phenocrysts of oxyhornblende, clinopyroxene, and well-zoned sodic andesine (An 30-38) in aphanitic groundmass of sanidine and oligoclase microlites and biotite and clinopyroxine. 80-160 feet thick. Description from source map: Powderhorn Quadrangle

Tld - Lake Fork Formation, rhyodacite dike (Oligocene and older?)

Intrusive into other rocks of Lake Fork Formation. As much as 60 feet thick. Description from source map: Gateview Quadrangle

Tll - Lake Fork Formation, quartz latite flows, autobreccia, and thin basal sedimentary breccia (Oligocene)

Quartz latite flows, autobreccia, and thin basal sedimentary breccia-Light gray to bluish gray, contains about 30 percent andesine (An 32-35), 4 percent oxyhornblende (altered to a mixture of calcite and iron oxides), and 2 percent biotite in fine-grained groundmass; replaced by pyrite in places along faults; flows locally enclose a few blocky xenoliths of nonwelded tuff. At least 200 feet thick. Description from source map: Powderhorn Quadrangle

Tlb - Lake Fork Formation, andesitic to quartz-latitic volcanic breccia (Oligocene and older?)

Dull brown to gray, coarse, angular, poorly sorted, in places showing large-scale stratification. As much as 500 feet thick. Description from source map: Gateview Quadrangle

Tlt - Lake Fork Formation, pumiceous tuff (Oligocene and older?)

White to brown; locally interlayered with Tlb and Tlg units at Round Mountain. As much as 125 feet thick. Description from source map: Gateview Quadrangle

Tlgc - Lake Fork Formation, tuffaceous gravel and volcanic conglomerate (Oligocene and older?)

Tlg - Lake Fork Formation, tuffaceous gravel and volcanic conglomerate (Oligocene and older?)
Tuffaceous gravel and volcanic conglomerate: buff colored; consists of well rounded, poorly sorted cobbles and boulders of andesite, rhyodacite, granite, gneiss, and Mesozoic quartzite in a tuffaceous matrix. As much as 500 feet thick. Description from source map: Gateview Quadrangle

Tla - Lake Fork Formation, andesite flows and autobreccia (Oligocene and older?)

Gray, aphanitic to porphyritic andesite flows and autobreccia consisting of phenocrysts of andesine, clinopyroxene, and oxyhornblende in a trachytic groundmass of andesine and sanidine microlites and abundant iron oxides. Nearly horizontal platy jointing common. As much as 300 feet thick. Description from source map: Gateview Quadrangle

Tlba - Lake Fork Formation, porphyritic andesite (Oligocene and older?)

Contains labradorite phenocrysts as much as 2 cm long in a dense black microcrystalline trachytic groundmass of andesine and sanidine microlites, interstitial iron oxides, and pale-green clinopyroxene. As much as 300 feet thick. Description from source map: Gateview Quadrangle

Te - Bedded tuffs of East Elk Creek (Oligocene)

Te - Tertiary Sediments and Volcanic Deposits, Bedded tuffs of East Elk Creek (Oligocene)
This unit contains interbedded tuff, tuffaceous sandstone, and siltstone. The unit is white to light-green-brown. Individual ash beds contain abundant white angular pumice lapilli (up to 5 mm), and smaller pumice fragments are common in the tuffaceous sandstones. This unit is typically covered by colluvium from stratigraphically higher gravels and welded tuffs in the Gunnison quadrangle. However, the unit is well exposed in several prominent white cliffs up to 40 m (130 ft.) high on the north side of Blue Mesa Reservoir, where the unit was mapped as a tuffaceous conglomeratic facies of the West Elk Breccia by Hedlund and Olson (1973). The unit is younger than a biotite-bearing pumice clast from the unit that was dated at 30.7 ± .4 Ma (Stork and Panter, unpublished data). This unit is 0-55 m (0-180 ft.) thick. Description from source map: Gunnison Quadrangle

Twu - West Elk Breccia, undivided (Oligocene)

Twt - West Elk Breccia (Oligocene)
Laharic volcanic breccia and tuff breccia containing thin interbeds of tuffaceous conglomerate. Breccia consists of coarse angular blocks of rhyodacite or andesite as much as 5 feet in diameter and minor amounts of Precambrian rocks and Mesozoic sandstone, all in a comminuted matrix of phenocrysts and lava fragments. Poorly sorted; large-scale stratification and crossbeds. Maximum thickness about 550 feet. Description from source map: Big Mesa Quadrangle

Tw - West Elk Breccia (Oligocene)
The West elk Breccia is predominantly a brownish-gray volcanic breccia and tuff breccia with minor interbedded tuff, tuffaceous sandstones and conglomerate. Breccia beds are pooly sorted, matrix supported, with large-scale stratification, and probably were emplaced as volcanic mud and debris flows. The clasts in the breccia include andesite, dacite, and rhyolite up to 2 m in diameter. Reworked

clasts of older West Elk Breccia are up to 4 m in diameter. Some debris-flow units in the West Elk Breccia contain reworked paleo-Gunnison and Tomichi stream gravels and therefore have clasts of Precambrian granite and metamorphic rocks and Paleozoic and Mesozoic sedimentary rocks in an ashy matrix. West Elk volcanism had been dated to 30.5 ± .8 Ma by Coven and others (1999). This unit thickens markedly across the quadrangle from zero in the northeast to at least 180 m (600 ft.) on the western edge of the quadrangle. Gaskill and others (1981) report a maximum thickness for the volcaniclastic facies of the West Elk Breccia of approximately 550 m (1800 ft.) in adjacent quadrangles. Description from source map: Gunnison Quadrangle

Twt - West Elk Breccia (Oligocene and older?)
Laharic volcanic breccia and tuff breccia, brownish gray, coarse, poorly sorted; stratified on a large scale; some channeling into underlying formations; locally includes interbeds of nonwelded tuff. Maximum remnant thickness of 140 feet. Description from source map: Iris NW Quadrangle

Twc - West Elk Breccia, tuff and tuffaceous conglomerate (Oligocene and older?)

Twc - West Elk Breccia - volcanic conglomerate (Oligocene and older (?)
Commonly underlying and interbedded with unit Twt; contains abundant well-rounded cobbles and boulders of intermediate volcanic rock, scattered cobbles and boulders of hypabyssal porphyry and Precambrian granitic rock, and occasional cobbles of gneiss, quartzite, and greenstone. As much as 200 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Twc - West Elk Breccia, tuff and tuffaceous conglomerate (Oligocene and older (?)
White to light-brown, locally well bedded, showing small-scale crossbedding. Commonly contains crystals of biotite, sodic andesine, quartz, and hornblende, and white pumice fragments. Probably represents airfall tuff reworked by streams, locally incorporating rounded cobbles and pebbles of Mesozoic quartzite and Precambrian granite and schist. Occurs mostly in northern part of quadrangle where it is typically 200-350 feet thick. Description from source map: Carpenter Ridge Quadrangle

Twc - West Elk Breccia - volcanic conglomerate (Oligocene)
No additional description provided on source map. Unit present on source map: McIntosh Mountain Quadrangle

Twt - West Elk Breccia, laharic volcanic breccia and tuff breccia (Oligocene and older?)

Twt – West Elk Breccia (Oligocene and older (?))
Latitic to andesitic tuff breccia as much as 800 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Twt - West Elk Breccia, laharic volcanic breccia and tuff breccia (Oligocene and older (?))
Brown to brownish-gray, coarse, poorly sorted angular fragments of rhyodacite or andesite in a comminuted matrix of phenocrysts and lava fragments. Large-scale stratification and crossbedding due to the alternation of very coarse, blocky breccia beds and fine-grained breccia beds. Thickness generally increases toward north edge of quadrangle where it is about 300-1,100 feet thick. Description from source map: Carpenter Ridge Quadrangle

Twvc - West Elk Breccia, volcaniclastic facies (Oligocene)
Brown to brownish-gray laharic volcanic breccia, tuff-breccias, tuffs, tuffaceous conglomerates, and tuffaceous sandstones. Breccias consist of massively bedded units of coarse angular fragments of andesite and dacite as much as 2 meters in diameter in a tuffaceous matrix. This unit was previously

mapped by as Twt by Hansen (1971), Hedlund and Olson (1973), and Hedlund (1974) and as Twvc by Gaskill et al. (1981). We recommend that Twvc supercede the older Twt on all the maps because it better describes the unit. Description from source map: McIntosh Mountain Quadrangle

Twf - West Elk Breccia, hornblende rhyodacite (Oligocene and older?)

Twf - West Elk Breccia (Oligocene and older (?)
Rhyodacitic, commonly autobrecciated flows, 20-80 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Twf - West Elk Breccia, hornblende rhyodacite (Oligocene and older (?))
Reddish-brown to gray, commonly autobrecciated, flow intercalated with Twt unit east of Fourmile Gulch in sec. 5, T.48N., R.3W. and sec. 36, T.49N., R.4W. Description from source map: Carpenter Ridge Quadrangle

Twf – West Elk Breccia, Flows (Oligocene)
Relatively thin flows of pyroxene and hornblende andesite and hornblende dacite and associated flow breccias. Description from source map: Little Soap Park Quadrangle

Twa - West Elk Breccia, ash-flow tuff lens (Oligocene and older?)

Ash-flow tuff lens, locally welded, as much as 200 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Twg - Gravels of the East Elk Tuff and West Elk Breccia (Oligocene)

Twg - West Elk Breccia, coarse gravel (Oligocene and older (?))
Discontinuous gravels containing pebbles and cobbles, chiefly of Precambrian granite, quartz-biotite schist, amphibolite and hornblende schist, and Mesozoic quartzitic sandstone. Description from source map: Carpenter Ridge Quadrangle

Twg - Tertiary Sediments, Gravel of the West Elk Breccia (Oligocene)
Well-rounded, unconsolidated river gravels are found within the West Elk Breccia as discontinuous lenses. Gravel deposits contain clasts from sand to boulder (up to 1.5 m) size. Boulders include Precambrian granites and metamorphic rocks, Paleozoic and Mesozoic sandstones, and Tertiary volcanics. Individual lenses of gravel are up to 30 m (100 ft.) thick. Description from source map: Gunnison Quadrangle

Tepg - Tuff of East Elk Creek, Precambrian-bearing gravels (Oligocene)
Discontinuous coarse gravels containing pebbles, cobbles, and boulders of various Precambrian plutonic and metamophic rocks, Paleozoic limestones and sandstones, and Mesozoic sandstones. We recommend that gravels mapped Twg beneath the Twc of Hedlund and Olson (1973) be renamed to this unit. Description from source map: McIntosh Mountain Quadrangle

Twr - West Elk Breccia, rhyolite and dacite domes (Oligocene)

Relatively thick domes or shallow intrusives of rhyolitic to dacitic composition. Description from source map: Little Soap Park Quadrangle

Twbc - West Elk Breccia, basal cone facies (Oligocene)

Porhyritic, massive to brecciated, dark gray, brown, greenish-gray, red, purple rocks of basaltic andesite lava flows, microdiorites, and quartz diorites. Widely propylitized and cut by dikes. Description from source map: Little Soap Park Quadrangle

Kcr - Cimarron Ridge Formation (Upper Cretaceous)

Laharic or pyroclastic andesitic breccia. Local remnants correlated with similar deposits to south on Cimarron Ridge in Washboard Rock quadrangle. Description from source map: Black Canyon of the Gunnison River and Vicinity

Kc - Camptonite (Upper Cretaceous)

Olive-gray medium-grained lamprophyric sills as much as 40 feet thick containing 25 percent labradorite, 9 percent augite, and 66 percent matrix, consisting of oligoclase, biotite, magnetite, analcite, chlorite, natrolite, and olivine, with much fibrous secondary serpentine or chlorite. Intrudes and bakes Mancos Shale southwest of Fitzpatrick Mesa. A fine-grained leucocratic variant that fills fractures in the camptonite consists of sanidine-albite minette. Description from source map: Black Canyon of the Gunnison River and Vicinity

Kf - Fruitland Formation (Upper Cretaceous)

Kf - Fruitland Formation (Upper Cretaceous)
White to dusky-yellow sandstone interbedded with coal, brown carbonaceous shale, and green to black shale. Poorly exposed; section incomplete. Description from source map: Black Canyon of the Gunnison River and Vicinity

Kf - Fruitland Formation (Upper Cretaceous) [2]
White to dusky-yellow sandstone interbedded with coal, brown carbonaceous shale, and green to black shale. Base of formation placed at lowest coal bed. Mostly slope-forming, poorly exposed. Only lower part of formation preserved in quadrangle; thickness probably less than 50 feet. Thickness of exposed coal-bearing equivalent of formation in adjacent area to south about 200 feet.

[2] These rocks included with the Mesaverde Group by Burbank and others, 1935. *Geologic Map of Colorado*: U.S. Geological Survey. Fossil collections, as shown in table 1, indicate the Mancos Shale of the Cerro Summit area is equivalent to Mancos Shale, Mesaverde Group, and Lewis Shale of type area.

Description and note from source map: Cerro Summit Quadrangle

Kfc - Fruitland Formation, coal bed at base of formation (Upper Cretaceous)

c - Fruitland Formation, coal bed (Upper Cretaceous)
Approx. 3 ft. thick; sub-bituminous, bony. Description from source map: Cerro Summit Quadrangle

Kpc - Pictured Cliffs Sandstone (Upper Cretaceous)

Kpc - Pictured Cliffs Sandstone (Upper Cretaceous)
White to dusky-yellow fine-grained calcareous sandstone overlying pale-olive to dusky-yellow calcareous shale and siltstone. Poorly exposed; about 200-250 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Kpc - Pictured Cliffs Sandstone (Upper Cretaceous) [2]
(200-250 ft.) Upper part white to dusky-yellow, fine-grained calcareous sandstone; lower part pale-olive to dusky-yellow interbedded calcareous shale and siltstone. Basal contact placed where shale becomes predominant. Cliff- and slope-forming.

[2] These rocks included with the Mesaverde Group by Burbank and others, 1935. *Geologic Map of Colorado*: U.S. Geological Survey. Fossil collections, as shown in table 1, indicate the Mancos Shale of the Cerro Summit area is equivalent to Mancos Shale, Mesaverde Group, and Lewis Shale of type area.

Description and note from source map: Cerro Summit Quadrangle

Km - Mancos Shale, undivided (Upper Cretaceous)

Km - Mancos Shale (Upper Cretaceous)
Gray silty shale. Largely eroded away before deposition of overlying volcanics. Shown in section only. Description from source map: Big Mesa Quadrangle

Km - Mancos Shale (Upper Cretaceous)
Dark-gray silty clay shale containing scattered lenses of friable gray sandstone and scattered calcareous siltstone concretions. Plastic when wet and susceptible to failure. SM, top of bluff-forming silty marker bed about 150 feet thick, southwest of Diehl Point. JL, top of Juana Lopez Member. Section incomplete but as much as 2,200 feet thick near axis of Montrose syncline and beneath Cathedral Peak. Description from source map: Black Canyon of the Gunnison River and Vicinity

Km - Mancos Shale (Upper Cretaceous)
Dark-gray silty clay shale. Description from source map: Black Ridge Quadrangle

Km - Mancos Shale (Upper Cretaceous)
Gray silty shale. Largely eroded away before deposition of overlying volcanics. The maximum exposed thickness remaining in the quadrangle is 220 feet in se. 25, T.49N., R.4W. Description from source map: Carpenter Ridge Quadrangle

Km - Mancos Shale (Upper Cretaceous)
Dark-gray to black shale, in part sandy, silty, and calcareous. Finely crystalline dark-gray limestone concretions common. Thin bentonite beds scattered throughout. Formation mostly covered, lower part not exposed. Exposed thickness not accurately determinable because of extensive landslide cover; may be as much as 3,000 feet. Total thickness of formation may be as much as 5,000 feet. Oldest exposed fossil zone collected, *Scaphites depressus* (USGS Mes. loc. D3844); youngest zone collected, *Exiteloceras jenneyi* (USGS Mes. locs. D3178, D4310). Zone of *Didymoceras cheyennense* collected at top of formation in adjacent area to south (USGS Mes. loc. D3861).[3]

[3] Fossil identifications by W.A. Cobban (written communication, 1961, 1962, 1963).

Description and note from source map: Cerro Summit Quadrangle

Km - Mancos Shale (Upper Cretaceous)
Soft, dark-gray, silty shale; scattered lenses of friable gray sandstone and calcareous concretions.

Present in three small areas in valley of the Lake Fork Gunnison River south of the Cimarron fault. Description from source map: Gateview Quadrangle

Km - Mesozoic Sedimentary Rocks, Mancos Shale (Upper Cretaceous)
Mancos Shale exposures in the Gunnison quadrangle consist of dark-gray to gray fissile shale and mudrock with rare, thin, tan sandstone and tan calcareous sandstone. The Mancos Shale underlies extensive areas of surficial Quaternary mass-movement and alluvial deposits in the northern half of the quadrangle. The widely separated distribution of small Mancos Shale outcrops in the Gunnison quadrangle precludes mapping of the individual members of the formation that were identified by Coogan and others (2005) in the Almont 7.5' quadrangle to the northeast (fig.1). In general, small outcrop areas east of the Gunnison River correlate to the lower member, and outcrops west of the Gunnison River correlate to the upper shale map unit of Coogan and others (2005). The intervening Mancos Shale map units in the Almont quadrangle include the calcareous shale of the Smoky Hill Member, the lower shale of the Smoky Hill Member, the Fort Hays Limestone Member, the unnamed shale member and the Juana Lopez Member, the Codell Sandstone Member, and the lower shale (Coogan and others, 2005). These units are either not exposed or are not distinguishable in the limited and small outcrops of the Gunnison quadrangle.> Description from source map: Gunnison Quadrangle

Km - Mancos Shale (Upper Cretaceous)
No additional description provided on source map. Unit present on source map: Little Soap Park Quadrangle

Kms - Mancos Shale, silty-marker bed (Upper Cretaceous)

SM - Mancos Shale, silty marker bed (Upper Cretaceous)
Top of bluff-forming silty marker bed about 150 feet thick, southwest of Diehl Point. Description from source map: Black Canyon of the Gunnison River and Vicinity

Kms - Mancos Shale, silty bed marker (Upper Cretaceous)
(150± feet) Pale-olive to dusky-yellow siltstone to argillaceous siltstone. A ledge-forming marker bed about 600 to 700 feet below top of formation. Probably in zone of *didymoceras nebrascense* (USGS Mes. loc. D3177). Description from source map: Cerro Summit Quadrangle

Kmjl - Mancos Shale, top of Juan Lopez Member (Upper Cretaceous)

JL - Mancos Shale, top of Juana Lopez Member (Upper Cretaceous)
No additional description present on source map. Unit present on source map: Black Canyon of the Gunnison River and Vicinity

b - Mancos Shale, bentonitic-marker (Upper Cretaceous)
(50± feet) Dark-brown to black bentonitic and gypsiferous zone forming prominent marker bed about in middle of formation. Description from source map: Cerro Summit Quadrangle

Kd - Dakota Sandstone (Upper Cretaceous)

Kd - Dakota Sandstone (Upper Cretaceous)
Lenticular white to yellow conglomeratic sandstone and interbedded sandstone and gray to black shale. Shale locally bleached white. Cliff- and ledge-forming. Incomplete lower part of section exposed; contains local white conglomeratic lenses at base that may be equivalent to Burro Canyon

Formation of adjoining region. Thickness about 90 ft.; total thickness in adjacent areas as much as 200 ft. Description from source map: Cerro Summit Quadrangle

Kd - Mesozoic Sedimentary Rocks, Dakota Sandstone (Upper Cretaceous)
The Dakota Sandstone is dominated by yellow-brown to gray sandstone with interbedded conglomerate and mudstone. Sandstone is quartz arenite with a minor component of chert grains. Chert and quartz pebble conglomerate marks the base, but conglomerate locally is absent where there are no scours. Three distinct parts are recognized in the map area. The lower third consists of resistant interbedded fine- to coarse-grained sandstone and pebble conglomerate that fills channel scours up to 3 m (10 ft) deep into underlying strata. This part is dominated by trough and low-angle cross-stratification with minor horizontal stratification. The middle part of the Dakota consists of a recessive zone of thinly bedded, brown and gray, carbonaceous, laminated, fine- to medium-grained sandstone, siltstone, and thin, silty coal horizons. Black carbonaceous clots and plant-stem impressions are abundant. The upper third of the Dakota consists of a resistant yellow-brown to gray sandstone that is overlain by medium-bedded bioturbated siltstone and interbedded gray to black silty shale. The Dakota Sandstone records a marine transgression. The basal third was deposited in braided streams. The middle part represents a swampy shoreline environment and the uppermost Dakota was deposited in a sandy, tide-influenced shallow marine environment. There is no complete exposure of the Dakota Sandstone in the Gunnison quadrangle. However, the Dakota Sandstone is 20 m (65 ft) thick in the Gunnison River Canyon immediately northeast of the map area (Coogan and others, 2005). Thickness of the Dakota varies with the depth of basal scours into underlying strata, and most variations are attributed to the lower fluvial part of the formation. The Dakota has a sharp unconformable contact on the Lower Cretaceous Burro Canyon Formation. The upper contact with the overlying Upper Cretaceous Mancos Shale is gradational and records a continued sea level rise into a deep marine environment. Description from source map: Gunnison Quadrangle

Kdbc - Dakota Sandstone and Burro Canyon(?) Formation, undivided (Upper and Lower Cretaceous)

Kdb - Dakota Sandstone (Upper and Lower (?) Cretaceous) and Burro Canyon Formation (Lower Cretaceous)
Generally light-brown, medium- to coarse-grained sandstone. Formations are largely eroded from the quadrangle. Upper part of remaining section consists of thinly bedded, silty sandstone that weathers into platy fragments. Lower part of section locally contains lenses of pebble conglomerate characterized by gray chert pebbles. Maximum thickness of erosional remnant is about 125 feet. Description from source map: Big Mesa Quadrangle

Kdb - Dakota Sandstone and Burro Canyon Formation (Upper and Lower Cretaceous)
Dakota Sandstone*:* mostly light-gray fine to very fine grained platy sandstone, commonly quartzitic, and dark-gray papery carbonaceous shale; coalbeds near base; minor conglomeratic sandstone. Ripple marks common toward top. Forms dip slopes.

Burro Canyon Formation*:* chiefly very light gray cross-bedded cliff-forming conglomeratic sandstone and pebbly conglomerate. Discontinuous beds of light-gray shale. Combined thickness of Dakota and Burro Canyon averages about 200 feet.

Description from source map: Black Canyon of the Gunnison River and Vicinity

Kdb - Dakota Sandstone and Burro Canyon Formation (Lower Cretaceous)
Dakota Sandstone*:* mostly fine- to very fine-grained light-gray platy sandstone, commonly quartzitic, and dark-gray papery carbonaceous shale; coal beds near base, minor conglomeratic sandstone. Ripple marks common toward top. Forms dip slopes

Burro Canyon Formation*:* chiefly very light gray cross bedded cliff-forming conglomeratic sandstone and pebble conglomerate. Pebbles mostly light- to dark-gray chert and quartzite.

Discontinuous beds of light-gray shale. Commonly truncates underlying Morrison Formation.

Description from source map: Black Ridge Quadrangle

Kdb - Dakota Sandstone and Burro Canyon Formation (Lower Cretaceous)
Generally light-brown, medium- to coarse-grained sandstone. Formations are largely eroded from the quadrangle. In upper part of remaining section, carbonaceous shale beds generally less than 6 inches thick are interbedded with silty sandstones. In northeast corner of quadrangle in section 19, the upper part contains fine-grained platy sandstones having sparse plant impressions. Sporadic lenses of pebble conglomerate characterized by gray and white chert pebbles in lower part of section are in the Burro Canyon Formation. Maximum thickness of unit remaining in quadrangle is about 200 feet. Description from source map: Carpenter Ridge Quadrangle

Kdb - Dakota Sandstone and Burro Canyon (?) Formation, undivided (Upper and Lower Cretaceous)
No additional description provided on source map. Unit present on source map: Little Soap Park Quadrangle

Kdb - Dakota Sandstone (Upper and Lower? Cretaceous) and Burro Canyon (?) Formation (Lower Cretaceous), undivided
Light-brown, medium-grained cross-bedded sandstone; sporadic lenses of gray chert-pebble conglomerate in lower section may be in Burro Canyon Formation. Maximum exposed thickness about 120 feet. Description from source map: Powderhorn Quadrangle

Kbc - Burro Canyon Formation (Lower Cretaceous)

Kbc - Mesozoic Sedimentary Rocks, Burro Canyon Formation (Lower Cretaceous)
The Burro Canyon Formation consists of basal cliff-forming conglomeratic sandstone that is interbedded with thin intervals of slope-forming varicolored claystone and mudstone in the upper part of the formation. The basal conglomeratic sandstone ranges from 0 to 12 m (0 - 40 ft) thick and consists of crossbedded chert pebble conglomerate that grades upwards into coarse- to fine-grained sandstone. The maximum thickness of the Burro Canyon Formation is estimated as 14 m (45 ft), however the thickness varies greatly because the Burro Canyon Formation scours deeply into the underlying Brushy Basin Member of the Morrison Formation. The formation is unconformably overlain by the Upper Cretaceous Dakota Sandstone. Description from source map: Gunnison Quadrangle

Jm - Morrison Formation (Upper Jurassic)

Jm - Morrison Formation (Upper Jurassic)
Variegated greenish-gray to reddish-brown mudstone, siltstone, and thin interbeds of lenticular sandstone. thin discontinuous bed of brecciated limestone is exposed in gully 0.5 mile southwest of Iola about 80 feet above the base of the formation. Maximum exposed thickness is 360 feet. Description from source map: Big Mesa Quadrangle

Jm - Morrison Formation (Upper Jurassic)
Brushy Basin Member*:* chiefly varicolored red, lavender, green, and light-gray bentonitic mudstone and silty shale, gray to lavender massive siltstone, and fine-grained light-gray sandstone. Mudstone plastic when wet. Pebble conglomerate containing red and green chert pebbles, and locally dinosaur bone, about 140 feet below top. Member is about 315-360 feet thick.

Salt Wash Member*:* chiefly light-gray massive to cross-bedded fine-grained cliff-forming sandstone interbedded with red silty shale. Sandstone beds lenticular fill channels. Member is

about 110-175 feet thick.

Description from source map: Black Canyon of the Gunnison River and Vicinity

Jm - Morrison Formation (Upper Jurassic)
Brushy Basin Member: chiefly varicolored red, lavender, green, and light-gray bentonitic mudstone, and silty shale, gray to lavender massive siltstone, and fine-grained light-gray sandstone. Pebble conglomerate, containing red and green chert pebbles, about 140 feet below top.

Salt Wash Member: chiefly light-gray massive to cross bedded with red silty shale. Sandstone beds are lenticular, fill channels cut into the shale, and contain chips or fragments of shale, especially toward their bases.

Description from source map: Black Ridge Quadrangle

Jm - Morrison Formation (Upper Jurassic)
Mudstone and siltstone and thin lenticular sandstone beds. Upper part is light green to gray mudstone and siltstone containing very thin intercalated silty sandstone beds. Lower half is red to purple mudstone containing thin lenticular sandstone beds. A charophyte-bearing limestone bed 2 feet thick occurs 45 feet above basal contact in sec. 27, T.49N., R.3W. Maximum exposed thickness of 425 feet is near Red Creek. Description from source map: Carpenter Ridge Quadrangle

Jm - Morrison Formation (Upper Jurassic)
Upper part, variegated red, green, purple, and gray shales with sandstone and conglomeratic sandstone lenses. Lower part, interbedded lenticular sandstone, siltstone, and mudstone; mostly shades of red and green. Slope-forming, poorly exposed. Incompletely exposed in several fault blocks; thickness may be as much as 400 feet. Total thickness in adjacent area about 600 feet. [4]

[4] Craig, L., Holmes, C.N., Freeman, V.L., Mullens, T.E., and others, 1959; *Measured sections of the Morrison Formation and adjacent beds in the Colorado Plateau Region, Colorado, New Mexico, and Utah*: U.S. Geological Survey open-file report.

Description and note from source map: Cerro Summit Quadrangle

Jm - Morrison Formation (Upper Jurassic)
Light-brown sandstone and variegated purple, greenish-gray, and dusky red mudstone; essentially flat-lying strata that crop out along both sides of Gold Basin Creek road at the north edge of the quadrangle. Maximum remnant thickness about 160 feet. Description from source map: Iris NW Quadrangle

Jm - Morrison Formation ((Upper Jurassic)
No additional description provided on source map. Unit present on source map: Little Soap Park Quadrangle

Jm - Morrison Formation (Upper Jurassic)
Mudstone, siltstone, and thin lenticular sandstone beds; reddish-brown to greenish-gray mudstone-siltstone predominates; thin discontinuous beds of orange and gray chert-pebble conglomerate are present in upper part of formation. 240-280 feet thick. Description from source map: Powderhorn Quadrangle

Jmb - Morrison Formation, Brushy Basin Member (Upper Jurassic)

Jmb - Mesozoic Sedimentary Rocks, Brushy Basin Member of the Morrison Formation (Upper Jurassic)

The Brushy Basin Member is a heterogeneous assemblage of lithologies and consists of irregular alternations of green siliceous claystone, red silty shale, gray limestone, and sparse lenses of sandstone and conglomeratic sandstone. Beds of all lithologies are less than 1.5 m (5 ft) thick. Green claystone is the dominant rock type and mostly is structureless, although laminations are locally evident. Laminated red silty shale increases in abundance toward the base of the member. Gray limestone is micritic and contains evidence of plant rootlets. Clasts in conglomeratic sandstone lenses are composed predominantly of intraclasts of limestone, green claystone, and red shale. The Brushy Basin Member is the product of a broad low-relief fluvial flood plain. Claystone and shale are flood-plain deposits. Lenticular sandstone and conglomerate bodies were deposited in the low energy river channels that cut across the flood plain. Limestone was deposited in shallow ponds that formed in depressions on the plain, between the river channels. North of U.S. Highway 50 where the base of the unit is not exposed, the maximum exposed thickness of the Brushy Basin Member is ~ 50 m (170 ft) near the east edge of the Gunnison quadrangle. The Brushy Basin Member reaches up to 70 m (230 ft) thick in the Almont quadrangle to the northeast (Coogan and others, 2005), but this thickness may include up to 19 m (63 ft) of the overlying Burro Canyon Formation, which is largely indistinguishable from the Brushy Basin in that area. The Brushy Basin forms sagebrush- covered slopes and mostly is concealed beneath a thick mantle of colluvium. Where it cannot be recognized by stratigraphic position, it typically is identified by chips of green and red shale in small drainages and gullies. Its recognition is further complicated by its tendency to collapse into landslides, slumps, and debris flows. The base of the Brushy Basin Member is not exposed in the quadrangle. Northeast of the quadrangle, the Brushy Basin Member rests conformably on the Salt Wash Member of the Morrison Formation, which is up to 6 m (20 ft) thick in the Almont quadrangle (Coogan and others, 2005). However, the fluvial channel facies of the Salt Wash Member is absent where the Brushy Basin rests conformably on the Jurassic Junction Creek Sandstone in exposures one half mile south of the center Gunnison quadrangle along County Road 38. Description from source map: Gunnison Quadrangle

Jw - Wanakah Formation (Upper Jurassic)

Jw - Wanakah Formation (Upper Jurassic)

Upper part*:* interbedded light-gray silty mudstone and medium-gray algal cherty limestone. 25-60 feet thick.

Jwj - Junction Creek Member: discontinuous fine-grained friable highly cross-bedded light-gray to light-yellowish-gray to pink eolian sandstone; mapped only in Curecanti Needle and Sapinero quadrangles but recognized elsewhere. As much as 90 feet thick.

Middle part*:* interbedded gypsum, friable gypsiferous sandstone, and soft gypsiferous mudstone as much as 145 feet thick in Red Rock Canyon and Grizzly Ridge quadrangles, thinning and becoming less gypsiferous eastward.

Pony Express Limestone Member*:* discontinuous, locally brecciated fetid pellatal to aphanitic silty gray limestone 1-7 feet thick. Nonexistent east of Dead Horse Mesa.

Description from source map: Black Canyon of the Gunnison River and Vicinity

Jw - Wanakah Formation (Upper Jurassic)

Upper part: Interbedded light-gray silty mudstone and medium-gray algal cherty limestone.

Jwj - Junction Creek Member: Discontinuous fine-grained friable highly crossbedded light-gray to light-yellowish-gray eolian sandstone; mapped only in the Smith Fork area but recognized elsewhere.

Middle part: Interbedded gypsum, friable gypsiferous sandstone, and soft gypsiferous mudstone; overall color very pale pink.

Pony Express Limestone Member: Discontinuous, locally brecciated, fetid pelletal to aphanitic silty gray limestone, 1-4 feet thick.

Description from source map: Black Ridge Quadrangle

Jw - Wanakah Formation (Upper Jurassic)
Upper part, interbedded sandstone, siltstone, gypsum, and mudstone. *Lower part*, fine-grained sandstone overlying basal finely crystalline olive-gray limestone (2-3 feet). Limestone, in part intraclastic, may be equivalent to *Pony Express Limestone Member*. Slope-forming, poorly exposed. Exposed thickness may be as much as 50 feet. Total thickness in adjacent area about 150 feet. Description from source map: Cerro Summit Quadrangle

Jj - Junction Creek Sandstone (Upper Jurassic)

Jj - Junction Creek Sandstone (Upper Jurassic)
Light-gray to buff, fine- to medium-grained, quartzose, massive, locally crossbedded, persistent sandstone. Locally quartzitic, especially where overlain by Tertiary volcanic rocks. As much as 180 feet thick. Description from source map: Big Mesa Quadrangle

Jwj - Junction Creek Member (Upper Jurassic)
Discontinuous fine-grained friable highly cross-bedded light-gray to light-yellowish-gray to pink eolian sandstone; mapped only in Curecanti Needle and Sapinero quadrangles but recognized elsewhere. As much as 90 feet thick. Description from source map: Black Canyon of the Gunnison River and Vicinity

Jwj - Wanakah Formation, Junction Creek Member (Upper Jurassic) [1]
Discontinuous fine-grained friable highly crossbedded light-gray to light-yellowish-gray eolian sandstone; mapped only in the Smith Fork area but recognized elsewhere.

[1] In the Black Canyon area the Junction Creek Sandstone is designated a member of the Wanakah Formation, although it has formation rank elsewhere. Where the Junction Creek is present in the Black Canyon area, it is overlain by 25-75 feet or so of light-gray silty mudstone containing thin beds of gray, in part algal, limestone. These strata, beneath the lowermost massive sandstone bed of the Salt Wash Member of the Morrison Formation, share the lagoonal or lacustrine depositional environment of the main body of the Wanakah Formation and are continuous with the main body where the Junction Creek is lacking. The Junction Creek is thus viewed as a discontinuous body of eolian sand deposited on the partly desiccated floor of the evaporitic Wanakah basin.

Description and note from source map: Black Ridge Quadrangle

Jj - Junction Creek Sandstone (Upper Jurassic)
White to light-brown, medium- to fine-grained, locally crossbedded, quartzose, probably eolian sandstone. Locally quartzitic, particularly where it underlies Tertiary volcanics. Commonly 50-100 feet thick. Description from source map: Carpenter Ridge Quadrangle

Jj - Junction Creek Sandstone (Upper Jurassic)
White to yellowish-gray, fine- to medium-grained, locally crossbedded, probably eolian, quartzose sandstone; commonly silicified and quartzitic. Locally present on Tolvar Peak. Description from source map: Gateview Quadrangle

Jj - Mesozoic Sedimentary Rocks, Junction Creek Sandstone (Upper Jurassic)
The Junction Creek Sandstone consists of well-sorted, fine- to medium-grained, yellow-white quartz sandstone. It is mostly crossbedded on a large scale with single sets up to 15 feet thick. The basal 3 to 5 m (10 - 16 ft) of the formation locally consists of medium-grained horizontal and wavy-bedded sandstone with abundant quartz granules and pebbles; symmetrical ripples of aqueous origin occur

rarely on bedding surfaces. The bulk of the formation was deposited in an eolian dune setting. Basal strata were deposited on a long-lived erosion surface in a marginal shallow marine setting. The top of the Junction Creek is not exposed in the quadrangle and the base is poorly exposed and typically covered by an apron of disaggregated sand grains. The formation nonconformably overlies Precambrian igneous and metamorphic rocks. The Junction Creek Sandstone has a maximum exposed thickness of ~15 m (50 ft) in the south-central part of the quadrangle, with a complete thickness of 27 to 38 m (90 - 125 ft) in the Almont quadrangle to the northeast (Coogan and others, 2005). The Junction Creek Sandstone is correlative with the Bluff Sandstone in southeast Utah on the basis of intertonguing of both of these units with the lower Morrison Formation (O'Sullivan, 1980, 1998, Coogan and others, 2005).> Description from source map: Gunnison Quadrangle

Jj - Junction Creek Sandstone (Upper Jurassic)
Light-gray to light-brown, fine- to medium-grained, quartzose sandstone; massive, thick-bedded, weakly cross-bedded; tightly cemented and quartzitic in upper part. Maximum thickness about 180 feet. Description from source map: Powderhorn Quadrangle

Je - Entrada Sandstone (Upper Jurassic)

Je - Entrada Sandstone (Upper Jurassic)
Yellow to pink very fine grained friable indistinctly cross-bedded eolian sandstone. Basal conglomerate 1-5 feet thick contains abundant fragments of locally derived Precambrian rock. Formation is 85 feet thick at Red Rock Canyon, thins eastward to 40 feet near Chasm View Overlook, and is nonexistent east of Poison Spring Hill. Description from source map: Black Canyon of the Gunnison River and Vicinity

Je - Entrada Sandstone (Upper Jurassic)
Mostly very fine-grained friable yellow to pink indistinctly crossbedded eolian sandstone. Just below the top is a zone of greenish-gray chrome-bearing sandstone a few inches to several feet thick, well defined in northern part of quadrangle but generally ill defined or absent in southern part. Light-brown, pink, or red basal conglomerate, 1-5 feet thick, contains abundant angular fragments of locally derived Precambrian rock. Description from source map: Black Ridge Quadrangle

Je - Entrada Sandstone (Upper Jurassic)
(0-50 ft.) Yellow fine-grained sandstone with some scattered medium to coarse, well-rounded grains. Basal part conglomeratic; contains detritus from underlying Precambrian rocks. Formation seems to pinch out to the east within quadrangle. Poorly exposed. Thickness in adjacent area about 85 feet. Description from source map: Cerro Summit Quadrangle

OCd - Diabase dikes (Ordovician or Cambrian)

OCd - Diabase Dike (Ordovician or Cambrian)
Black, fine- to medium-grained diabase dike which has thin, chilled, aphanitic margins; rusty brown on weathered surfaces and local spheroidal weathering structure. Contains labradorite (An 53-55), augite, accessory magnetite, secondary quartz, brown amphibole, chlorite, and apatite. Probably correlative with diabase dikes in the Black Canyon region, which have been radiometrically dated as 510+/-60 million years (Hansen and Peterman, 1968). Maximum individual thickness of the four dikes mapped is 75 feet. Description from source map: Big Mesa Quadrangle

OCd - Diabase (Upper Cambrian or Lower Ordovician)
Dark-gray to black fine-to medium-grained dikes containing about 44-55 percent labradorite, 25-35 percent augite, 3-8 percent quartz, 7-16 percent micropegmatite, 3-4 percent magnetite, and traces of biotite, hornblende, chlorite, epidote, pyrite, and apatite. Radiometric age, based on rubidium-strontium analyses of whole-rock and potassium-feldspar samples is 500+/-70 million years.(2) Arrow

indicates dip. Description from source map: Black Canyon of the Gunnison River and Vicinity

OCd - Diabase dikes (Cambrian or Ordovician)
Dark-brownish-gray to black, medium-grained diabase and gabbro composed of labradorite, augite, and lesser amounts of magnetite and quartz. Marginal zones and thin dikes commonly aphanitic. Radiometric age of 510+/-60 million years was obtained on a similar dike in the Black Canyon to the west (Hansen and Peterman, 1968). Description from source map: Carpenter Ridge Quadrangle

OCd - Diabase dikes (Cambrian or Ordovician)
Dark-brownish-gray to black, medium-grained diabase and gabbro composed of labradorite, augite and lesser amounts of magnetite and quartz. Marginal zones and thin dikes commonly aphanitic. Radiometric age of 510+/-60 million years was obtained on a similar dike in the Black Canyon to the northwest (Hansen and Peterman, 1968). Description from source map: Gateview Quadrangle

OCd - Diabase dikes (Ordovician or Cambrian)
Dark-gray brown-weathering fine-grained diabase having aphanitic margins; composed of 56 percent labradorite, 33 percent augite, and 5-10 percent brown amphibole, iron oxides, and secondary quartz. Dikes are less than 50 feet thick. Description from source map: Iris NW Quadrangle

OCd - Diabase dikes (Ordovician or Cambrian)
Dark-brownish-gray to black, medium-grained diabase and gabbro composed of labradorite (An 52-55), augite, and lesser amounts of magnetite and secondary quartz marginal zones and thin dikes commonly aphanitic. The 14 dikes mapped strike N. 55°-80° W. and dip steeply to vertically. Radiometric age of 510+/-60 m.y. (million years) was obtained on a similar dike in the Black Canyon to the northwest (Hansen and Peterman, 1968). Description from source map: Powderhorn Quadrangle

CPCt - Thorium veins (Cambrian or Upper Precambrian)

t - Thorium veins (Cambrian or Upper Precambrian)
Veins consisting of orthoclase, smoky quartz, barite, specularite, hematite, goethite, thorogummite(?), thorite, calcite, fluorite, sodic amphibole, pyrite, chalcopyrite, galena, sphalerite, and apatite. Veins generally less than a foot thick but may be as much as 10 feet wide in anastomosing shear and breccia zones. Description from source map: Powderhorn Quadrangle

CPCtd - Trachyte and trachyte porphyry dikes (Cambrian or Upper Precambrian)

t - Trachyte dikes (Precambrian)
Pink to red trachyte and trachyte porphyry dikes. A few aligned lathe-shaped orthoclase phenocrysts 3-5 mm long occur in a trachytic groundmass of orthoclase microlites; the orthoclase contains abundant dusty, ferric oxide inclusions. Weakly radioactive, 2-3 times background count. Twenty-one thin dikes have been mapped in the southeastern part of the quadrangle. Commonly 5-15 feet thick. Description from source map: Big Mesa Quadrangle

t - Trachyte and trachyte porphyry dikes (Cambrian or Upper Precambrian)
Pink to red, porphyritic to aphanitic dike rocks in which lath-shaped orthoclase phenocrysts as much as 1 cm long and containing dusty ferric oxide inclusions are set in a groundmass of aligned orthoclase microlites; autobreccia of angular coarse orthoclase aggregates in a fine-grained trachytic groundmass is common; dikes generally less than 10 feet thick; radioactivity of dikes due chiefly to thorium. Description from source map: Powderhorn Quadrangle

CPCc - Carbonatite (Cambrian or Upper Precambrian)

c - Carbonatite dikes (Precambrian or Cambrian)
Small dikes composed chiefly of dolomitic carbonate; related to complex of alkalic rocks at Iron Hill in the Powderhorn quadrangle to the southeast. Wall rocks commonly feldspathized to form fenite within a few feet of dike (sec. 32, T.47N., R.2W.) Description from source map: Gateview Quadrangle

c - Carbonatite (Cambrian or Upper Precambrian)
Light-brown to very light gray, foliated to massive carbonatite composed of dolomite, ankerite, calcite, siderite, fluorapatite, fluorite, barite, pyrochlore, synchisite, parisite, pyrite, pyrrhotite, chalcopyrite, galena, sphalerite, goethite, hematite, maghemite, rutile, magnetite, biotite, phlogopite, aegirine, and sodic amphibole. Stock of Iron Hill predominantly dolomite and ankeritic dolomite. At least 215 dikes of dolomitic, calcitic, ankeritic, and siderite carbonatite were mapped in pyroxenite and other rocks of the alkaline complex of Iron Hill; at least 30 dikes and plugs of carbonatite were mapped in Precambrian rocks outside the complex; jasper veins locally present within the stock. Description from source map: Powderhorn Quadrangle

CPCns - Nepheline syenite (Cambrian or Upper Precambrian)

ns - Nepheline syenite (Cambrian or Upper Precambrian)
Light-gray to pinkish-gray, medium- to coarse-grained, commonly trachytic nepheline syenite; this rock is composed of orthoclase, microperthite, and albite with about 10 percent interstitial aegirine-augite, nepheline and its alteration products (Larsen, 1942), plus accessory amounts of weakly zoned melanite, magnetite, sphene, biotite, apatite, calcite, sericite, cancrinite(?), and zircon. Small stock and dikes in southeast part of quadrangle cut granite, pyroxenite, and fenitized granite. Some very thin dikes in rocks altered to fenite are irregularly folded or crenulated as though deformed while still viscous. Description from source map: Powderhorn Quadrangle

CPCps - Pyroxenite-nepheline syenite hybrid rock (Cambrian or Upper Precambrian)

ps - Pyroxenite-nepheline syenite hybrid rock (Cambrian or Upper Precambrian)
Brecciated pyroxenite containing numerous irregular fracture fillings and small dikes of nepheline syenite. The pyroxenite contains diopside, zoned melanite, sphene, apatite, and sparse melilite. The nepheline syenite consists of orthoclase, microperthite, aegirine-augite, nepheline, and its alteration products, and minor amounts of melanite. Description from source map: Powderhorn Quadrangle

CPCi - Ijolite (Cambrian or Upper Precambrian)

i - Ijolite (Cambrian or Upper Precambrian)
Coarse- to fine-grained, hypidiomorphic-granular ijolite; commonly consists 30-50 percent nepheline, 30-40 percent aegirine-augite, 10-30 percent melanite, and minor amounts of orthoclase, magnetite, apatite, and very fine grained alteration products of nepheline, euhedral, light-pinkish-gray nepheline grains as much as 8 mm across form clotted aggregates whereas the anhedral aegirine-augite is very fine grained and fills interstices between the aggregated nepheline crystals. Description from source map: Powderhorn Quadrangle

CPCmt - Magnetite-ilmenite-perovskite dikes and segregations (Cambrian or Upper Precambrian)

mt - Magnetite-ilmenite-perovskite dikes and segregations (Cambrian or Upper Precambrian)
Composed of these three minerals and apatite and biotite. Chiefly confined to the pyroxenite in a west-northwest-trending belt north of Deldorado Creek and at the northwest end of the complex of Iron Hill; commonly less than 2 feet thick but some as much as 150 feet thick; discontinuous and rarely traceable for more than 100 feet; perovskite may make up as much as 50 percent of the rock. Radioactivity of the dikes is 2-12 times background and is due to presence of thorium in the perovskite lattice. Description from source map: Powderhorn Quadrangle

CPCp - Pyroxenite (Cambrian or Upper Precambrian)

py - Pyroxenite (Precambrian or Cambrian)
Black, medium- to coarse-grained pyroxenite consisting of altered pyroxene, phlogopite, and accessory carbonate and iron oxides. Age relation to granite uncertain. Only occurrence is a small body about 20 by 50 feet in granite of Tolvar Peak (sec. 24, T.47N., R.3W.). Description from source map: Gateview Quadrangle

p - Pyroxenite (Cambrian or Upper Precambrian)
Medium- to coarse-grained, locally pegmatitic pyroxenite containing 55-70 percent diopsidic augite, 10-15 percent magnetite and ilmenite, 5-25 percent melanite, 5 percent fluor-apatite, and 10 percent biotite and phlogopite; accessory minerals are commonly sphene, brown amphibole, calcite, perovskite, leucoxene, sodic amphibole (richterite), melilite, sericite, pyrite, chalcopyrite, and pyrrhotite; vermiculite and iron ores locally abundant in pod-like bodies; hypidiomorphic-granular to poikilitic texture, which is commonly shown by inclusions of sphene in melanite, perovskite in magnetite, and apatite in melanite, diopsidic augite and biotite. Two samples from pyroxenite, on North Beaver Creek at 8,800 feet elevation and from a point about 2,500 meters to the north have been dated by K-Ar methods as about 574±13 and 567+/-12 m.y., respectively (R.F. Marvin, written commun., 1973). Description from source map: Powderhorn Quadrangle

CPCmo - Melanite-orthoclase rock (Cambrian or Upper Precambrian)

mo - Melanite-orthoclase rock (Cambrian or Upper Precambrian)
Coarse-grained to pegmatitic, panidiomorphic-granular rock; euhedral poikilitic black melanite grains as much as 2.5 cm across with interstitial laths of orthoclase. Minor green fluor-apatite as inclusions and fracture fillings in melanite; accessory sodic amphibole. Mapped in only one area at edge of complex of Iron Hill north of Huntsman Gulch. Description from source map: Powderhorn Quadrangle

CPCbx - Intrusive breccia (Cambrian or Precambrian)

bx - Intrusive breccia (Precambrian or Cambrian)
Breccia composed of randomly oriented, diverse Precambrian rock fragments set in a light-green or gray groundmass of comminuted rock fragments, ankerite or dolomite, and opaque minerals. The rock fragments, 3 to more than 12 inches across, are angular to well-rounded and consist of hornblende schist and gneiss, quartz-biotite schist, biotite gneiss, sparse albite syenite, and abundant granite, part of which contains garnet. Hornblende fragments show a red, marginal alteration zone as much as ½ inch thick in which hornblende is altered to a mixture of iron oxides, dolomite, quartz, and minor chlorite. Rock fragments more than ¼ inch in diameter constitute 20-60 percent of the breccia. Description from source map: Carpenter Ridge Quadrangle

PCqv - Quartz veins (Precambrian)

qv - Quartz veins (Precambrian)-
Quartz veins containing traces of pyrite. Commonly less than 3 feet thick. Description from source map: Big Mesa Quadrangle

q – Quartz veins (Precambrian)
No additional description provided on source map. Unit present on source map: Carpenter Ridge Quadrangle

qv - Quartz veins (Precambrian)
No additional description provided on source map. Unit present on source map: Iris NW Quadrangle

PCfg - Fine-to medium-grained granite (Precambrian?)

fg - Fine- to medium-grained granite (Precambrian)
Light-gray granite, locally pinkish-gray to red on weathered surfaces; xenomorphic granular texture; in places, schistose to gneissic; consists of orthoclase, microcline, sodic plagioclase, quartz, biotite, and accessory apatite, magnetite, zircon, garnet, allanite, sericite, epidote, and chlorite. Description from source map: Powderhorn Quadrangle

PCwc - Granite dikes of Wolf Creek (Precambrian)

wc - Syenitic and related rocks, granite dikes of Wolf Creek (Precambrian)
Small stocks and dikes of pink, medium-grained granite and quartz syenite which cut other syenitic rocks and Black Canyon Schist in Wolf Creek area in southeast corner of quadrangle. Description from source map: Carpenter Ridge Quadrangle

PCmi - Minette (Precambrian)

m - Syenitic and related rocks, minette (Precambrian)
Dark, fine- to medium-grained dike rocks composed of microcline, biotite, and calcite in variable amounts. Age relations to other syenitic rocks uncertain. Description from source map: Carpenter Ridge Quadrangle

m - Syenitic rocks, minette (Precambrian)
Black to dark-gray, fine- to medium-grained lamprophyre composed of biotite, potassium feldspar, calcite, and in some dikes hornblende. Occurs as dikes and small plugs. A sample of biotite from biotite-calcite minette 0.6 mile northeast of Cebolla Creek in sec.7, T.47N., R.2W. has a K-Ar age of 1,330+/-40 million years as determined by R.F. Marvin (written commun., 1968). Description from source map: Gateview Quadrangle

PCcs - Coarse-grained biotite syenite and hornblende syenite (Precambrian)

cs - Syenitic and related rocks, coarse-grained biotite syenite and hornblende syenite (Precambrian)
Poikilitic microcline commonly encloses biotite flakes. Age relations to other syenitic rocks uncertain. Description from source map: Carpenter Ridge Quadrangle

PCsy - Quartz syenite, syenite, and granite (Precambrian)

s - Syenitic and related rocks, pink to gray leucosyenite (Precambrian)
Composed of microcline and minor biotite; and minor gray medium-grained hornblende syenite. Generally fine-grained in thin dikes; both coarse- and fine-grained textures are found in the larger bodies. Description from source map: Carpenter Ridge Quadrangle

s - Syenitic rocks, leucosyenite (Precambrian)
Light-pink to gray leucosyenite composed of microcline and minor biotite. Commonly fine-grained in thin dikes; both coarse- and fine-grained textures are found in the larger bodies.Description from source map: Gateview Quadrangle

sy - Quartz syenite, syenite, and granite (Precambrian)
Light-pinkish-gray, hypidiomorphic granular rock, typically contains 70-75 percent perthitic microcline, 2-15 percent quartz, 0-10 percent biotite, and accessory hornblende, apatite, and ferric oxides. Occurs in two small plug-like bodies along north margin of quadrangle and as pegmatitic granite dikes cutting augite syenite body near Spencer. Description from source map: Powderhorn Quadrangle

PCcms - Calcite-rich mafic syenite (Precambrian)

cms - Syenitic and related rocks, calcite-rich mafic syenite (Precambrian)
Found in sec. 13, T.48N., R.3W. Description from source map: Carpenter Ridge Quadrangle

PCbs - Biotite syenite (Precambrian)

bs - Biotite syenite (Precambrian)
Gray, medium- to coarse-grained, hypidiomorphic granular, commonly contains 40-45 percent microcline, 20-35 percent poikilitic biotite, 5-15 percent sodic amphibole, 5 percent quartz, and accessory augite, calcite, albite, chlorite, epidote, and iron oxides; the biotite typically occurs as plates 3-5 mm across which are molded about the laths of microcline. Radiometric age of small plug-like body at the Old Lot mine determined to be 1,390 m.y. by K-Ar methods on biotite (Olson and Marvin, 1971). Unit also includes four dikes of biotite-calcite minette shown in west part of map. Description from source map: Powderhorn Quadrangle

PCas - Augite syenite (Precambrian)

as - Syenitic rocks, porphyritic augite syenite (Precambrian)
Dark-gray to black, fine- to medium-grained porphyritic augite syenite; small phenocrysts of biotite, augite, and hornblende are disseminated in a very fine grained groundmass of these minerals plus microcline and magnetite. Description from source map: Gateview Quadrangle

as - Augite syenite (Precambrian)
Medium-gray, fine-grained, porphyritic with phenocrysts of zonally altered, partly uralitized augite; commonly contains 65-70 percent microcline, 4-20 percent augite, as much as 20 percent uralitic hornblende or actinolite after augite, 5-10 percent chlorite replacing hornblende, as much as 10 percent biotite, and accessory amounts of secondary quartz, iron oxides, apatite, and calcite. Occurs as small plugs at Spencer and on Willow Creek Description from source map: Powderhorn Quadrangle

PCop - Olivine pyroxenite (Precambrian)

op - Olivine pyroxenite (Precambrian)
Black, massive, medium-grained to porphyritic pyroxenite; consists chiefly of augite plus 4-5 percent labradorite (An50-52), less than 10 percent olivine, and as much as 2 percent biotite. Small stock about 800 by 1,600 feet at confluence of Willow and Sugar Creeks. Description from source map: Big Mesa Quadrangle

PCmr - Metarhyolite dikes (Precambrian)

mr - Metarhyolite dikes (Precambrian)
Very light yellowish gray, weakly foliated rhyolite composed of 3-5 percent phenocrysts of quartz and alkali feldspar in a very fine grained groundmass of alkali feldspar, quartz, and muscovite. Mapped in south-central part of quadrangle. Description from source map: Iris NW Quadrangle

PCfs - Fine-grained melasyenite (Precambrian)

fs - Syenitic and related rocks, quartz veins (Precambrian)
Fine-grained melasyenite: composed of pyroxene, biotite, and microcline plus sporadic phenocrysts of olivine. Age relations to other syenitic rocks uncertain. Description from source map: Carpenter Ridge Quadrangle

PCps - Gray porphyritic syenite (Precambrian)

ps - Syenitic and related rocks, gray porphyritic syenite (Precambrian)
Small phenocrysts of biotite, augite, and hornblende are disseminated in a very fine-grained groundmass of these minerals plus microcline and magnetite. Description from source map: Carpenter Ridge Quadrangle

PCms - Melasyenite (Precambrian)

ms - Syenitic and related rocks, medium- to coarse-grained melasyenite (Precambrian)
Composed of biotite, augite, and microcline and accessory hornblende, chlorite, apatite, and locally pyrite and olivine. A sample of biotite from melasyenite on west side of Wolf Creek in sec. 19, T.48N., R.2W., has a K-Ar age of 1,380 million years as determined by R.F.Marvin (written commun., 1968). Description from source map: Carpenter Ridge Quadrangle

ms - Syenitic rocks, melasyenite (Precambrian)
Black, medium- to coarse-grained melasyenite, hornblende syenite, and biotite syenite, composed of biotite, augite, and microcline, and accessory hornblende, chlorite, apatite, and locally olivine; microcline commonly encloses biotite poikilitically. Locally present in sec. 10, 11, and 13. T.47N., R.3W. A sample of biotite from melasyenite 1.1 miles south of northeast corner of quadrangle has a K-Ar age of 1,390+/-40 million years as determined by R.F. Marvin (written commun., 1968). Description from source map: Gateview Quadrangle

PCc - Curecanti Quartz Monzonite (Precambrian)

pCc - Curecanti Quartz Monzonite (Precambrian)
Light-gray to orange-pink, medium-grained sodic quartz monzonite or granite. The major pluton is texturally massive, but minor ones are mostly weakly foliated. Chief constituents are about 34 percent quartz, about 33 percent plagioclase (An 8-22), and about 26 percent microcline; subordinate constituents are 4 percent biotite, 3 percent muscovite, and epidote, garnet apatite, sphene, opaque iron minerals, and zircon. Locally alaskitic. Radiometric age, based on whole-rock rubidium-strontium isochron, is 1420+/-15 million years. Description from source map: Black Canyon of the Gunnison River and Vicinity

PCg - Gabbro (Precambrian)

pCg - Gabbro (Precambrian)
Olive-black coarse-grained olivine gabbro; predominant minerals plagioclase, olivine, and pyroxene. Description from source map: Cerro Summit Quadrangle

PCp - Pegmatite (Precambrian)

pCp - Pegmatite (Precambrian)
Very coarse variably grained dikes and sills composed chiefly of microcline, quartz, muscovite, and less commonly albite; locally contains subordinate biotite, garnet, tourmaline, or hematite. Many small bodies not mapped. Locally includes or grades into alaskitic granite. Intrudes all other Precambrian rocks and probably ranges widely in age; a sample collected in a quarry in NW ¼ sec. 1, T. 48 N., R. 5 W. has a radiometric age of 1360+/-40 million years, based on a rubidium-strontium analysis of microcline. Arrow indicates dip. Description from source map: Black Canyon of the Gunnison River and Vicinity

pCp - Pegmatite (Precambrian)
Very coarse variably grained dikes and sills composed chiefly of microcline, quartz, muscovite, and less commonly albite; some bodies contain subordinate biotite, garnet, tourmaline, or hematite. Many small dikes not mapped. Description from source map: Black Ridge Quadrangle

p - Granitic rocks, pegmatite dikes (Precambrian)
White to light-pink granitic pegmatites composed of perthite, quartz, and small amounts of mica. About 150 pegmatite bodies have been mapped in the quadrangle. The dikes are generally 5-15 feet thick, although some are as much as 150 feet thick. Description from source map: Carpenter Ridge Quadrangle

pCp - Pegmatite (Precambrian)
White to pink chiefly concordant lenticular or sill-like bodies comprised of very coarse-grained mixtures of quartz, feldspar, and mica. Some discordant lenticular and irregularly shaped masses. Description from source map: Cerro Summit Quadrangle

PCv - Vernal Mesa Quartz Monzonite (Precambrian)

pCv - Vernal Mesa Quartz Monzonite (Precambrian)
Mottled pinkish-gray very coarse grained porphyritic weakly to strongly foliated quartz monzonite near to granodiorite in composition. Average normative composition of 4 samples is: 43 percent plagioclase (An 34), 22 percent orthoclase (microcline), and 15 percent quartz. Other modal minerals are biotite,

opaque iron minerals (mostly magnetite), epidote, sphene, hornblende, apatite, and calcite. Radiometric age, based on whole-rock rubidium-strontium isochron, is 1480+/-40 million years. Description from source map: Black Canyon of the Gunnison River and Vicinity

PCgqm - Granite and quartz monzonite (Precambrian)

g - Granite and leucogranite dikes (Precambrian)
Granite is light pinkish gray and fine grained; consists of 27-32 percent perthitic microcline, 32-40 percent poorly twinned albite-oligoclase, 30 percent quartz, sparse biotite, and accessory muscovite, apatite, ferric oxides, and chlorite. Occurs as small stocks and irregular bodies. Leucogranite dikes are aplitic to fine grained and commonly strike N. 20° to 50° E. About 420 dikes, each as much as 150 feet thick. Description from source map: Big Mesa Quadrangle

pCqm - Quartz monzonite or granite (Precambrian)
Light-gray to pink quartz monzonite or sodic granite of varied composition and texture in small scattered bodies. Mostly lenticular and strongly foliated parallel to borders. May range widely in age. Small nonfoliated stock of coarse pink biotite albite microcline granite in secs. 19 and 30, at Little Willow Creek in the SE corner of Sapinero quadrangle. Description from source map: Black Canyon of the Gunnison River and Vicinity

g - Granitic rocks, granite and quartz monzonite (Precambrian)
Dikes or small stocks of pink, medium- to fine-grained to aplitic leucogranite and quartz monzonite, generally having little or no foliation. A few small bodies of biotite granite are present. Fine- to medium-grained, grayish-pink quartz monzonite that occurs in hornblende schist of Dubois Greenstone near south edge of the quadrangle is schistose and sericitic. Description from source map: Carpenter Ridge Quadrangle

g - Granitic rocks, leucogranite and quartz monzonite, undifferentiated (Precambrian)
Pink, fine- to medium-grained, occurring as dikes or small stocks; unit locally includes some small bodies of Powderhorn Granite and granite of Tolvar Peak; these rocks where enclosed in Dubois Greenstone or felsite are commonly schistose or lineated. Description from source map: Gateview Quadrangle

g - Granite, undifferentiated (Precambrian)
Light-pinkish-gray, fine- to medium-grained granite; consists of perthite microcline, albite-oligoclase, quartz, sparse biotite, and accessory muscovite, apatite, ferric oxides, and chlorite. Occurs as dikes, small stocks, and irregular bodies in the southwest quarter of the quadrangle. Description from source map: Iris NW Quadrangle

g - Leucogranite and quartz monzonite (Precambrian)
Light-pinkish-gray, medium- to fine-grained, weakly foliated; locally abundant elongate xenoliths of schist parallel to foliation; consists of 15-30 percent perthitic microcline, 35-45 percent sodic oligoclase (An 12-15), 25 percent quartz, as much as 8 percent biotite, and accessory muscovite, apatite, sphene, ferric oxides, and epidote. Occurs as irregular bodies and dikes in northeast part of quadrangle. Description from source map: Powderhorn Quadrangle

PCl - Lamprophyre (Precambrian)

pCl - Lamprophyre (metavogesite) (Precambrian)
Mottled greenish-gray fine-grained porphyroblastic partly metamorphosed hypabyssal dikes retaining well-defined chilled borders. Approximate minerals constituents are 43 percent hornblende, 36 percent microcline, 10 percent oligoclase, 5 percent biotite, 4 percent sphene, and 1 percent apatite. Description from source map: Black Canyon of the Gunnison River and Vicinity

Pitts Meadow Granodiorite

Medium-grained gneissic granodiorite or quartz diorite. [2]

[2] Definition of the Pitts Meadow Granodiorite

> The Pitts Meadow Granodiorite is here named for the prominent rocky mesa of the same name in the southwest part of the Black Ridge quadrangle, designated as the type area. The formation is well-exposed on the top of Pitts Meadow, particularly in numerous shallow gullies on top, and in the steep canyon walls that flank the mesa above the Gunnison River. Good exposures are abundant also in nearly continuous outcrops along the length of the Black Canyon between Pitts Meadow and Smith Fork and in the lower part of the gorge of Crystal Creek.
>
> The rock consists chiefly of strongly to weakly foliated medium-grained gneissic trondhjemitic granodiorite or quartz diorite. Mineral proportions vary considerably from place to place. A predominant light-colored phase contains about 45-55 percent plagioclase, 25-35 percent quartz, 2-18 percent microcline, 5-15 percent biotite, less than 1-5 percent hornblende, and accessory sphene, epidote, hematite, apatite, and zircon. A dark-colored variant, which truncates the light-colored phase, predominates on the southeast part of Pitts Meadow and is sub-ordinate elsewhere. It resembles the light-colored phase texturally and mineralogically but contains about 1/3 hornblende and biotite in subequal amounts. Highly mafic phases are exposed near the southeast border of the mass.
>
> Contact relations are best seen at Crystal Creek, near Smith Fork, and in a large ravine west of the Gunnison River 1 1/2 miles southwest of the mouth of Smith Fork. Contacts between the pluton and its walls are mostly concordant or nearly so and are parallel to the foliation of both the wallrock and the pluton. Local discordances, however, are not unusual. Contacts against quartzitic or migmatic gneiss tend to be gradational through a distance of as much as several hundred feet, but against amphibolite they tend to be sharp.
>
> Abundant mafic xenoliths--some angular and sharply bounded, others ill-defined and seemingly blurred by reaction with the magma--suggest stoping and partial assimilation. Most of the xenoliths are strongly oriented parallel to the foliation, as if they have been rotated by magmatic flowage. Lenticular schlieren-like inclusions probably are disintegrated xenoliths smeared out by flowage.
>
> The Pitts Meadow pluton probably is batholithic in size, although its surface exposure is only a few square miles. Field relations suggest a catazonal, syntectonic intrusive environment. Radiometric age, as determined from whole rock rubidium-strontium analyses by Z.E. Peterman and C.E. Hedge of the U.S. Geological Survey, is 1.73+/-0.19 billion years.

Description and note from source map: Black Ridge Quadrangle

PCpm - Pitts Meadow Granodiorite,predominant-light colored phase (Precambrian)

pCpm - Pitts Meadow Granodiorite, predominant light-colored phase (Precambrian)
Predominant light-colored phase. Description from source map: Black Ridge Quadrangle

PCpv - Pitts Meadow Granodiorite, dark-colored variant (Precambrian)

pCpv - Pitts Meadow Granodiorite, dark-colored dioritic variant (Precambrian)
Mostly medium-dark to dark-gray medium-grained variably foliated quartz diorite and diorite. Main body of rock is in Black Ridge quadrangle. Radiometric age, based on whole-rock rubidium-strontium isochron, is 1730+/-190 million years. Description from source map: Black Canyon of the Gunnison River and Vicinity

pCpv - Pitts Meadow Granodiorite (Precambrian)
Dark-colored variant. Description from source map: Black Ridge Quadrangle

PCcg - Granite and quartz syenite of Carpenter Gultch (Precambrian)

cg - Granitic rocks, Granitic and quartz syenite of Carpenter Gulch (Precambrian)
Composed of pink, medium- to coarse-grained, perthitic microcline, 10-15 percent quartz, and minor biotite and muscovite. Description from source map: Gateview Quadrangle

PCgpg - Leucogranite and quartz monzonite (Precambrian)

pg - Porphyritic granite (Precambrian)
Essentially the same as the nonporphyritic granite (g) but contains microcline phenocrysts as much as 1.5 cm long. Numerous small stocks and irregular bodies show various age relationships to those of the nonporphyritic variety of granite and are nearly contemporaneous with them. Description from source map: Big Mesa Quadrangle

PCpo - Powderhorn Granite (Precambrian)

po - Granitic rocks, Powderhorn Granite (Precambrian)
A pink, medium- to coarse-grained, gneissic biotite granite and quartz monzonite, locally porphyritic having microcline phenocrysts as much as 2 cm long, commonly forms elongate stocks broadly parallel to foliation. Description from source map: Gateview Quadrangle

po - Powderhorn Granite (Precambrian)
Light-pinkish-gray, medium- to coarse-grained granite, locally porphyritic with pink microcline phenocrysts as much as 2 cm long; weak foliation strikes N. 70°-90° W. with nearly vertical dip. Locally altered to fenite near the complex of alkaline rocks of Iron Hill. Description from source map: Powderhorn Quadrangle

PCgb - Quartz diorite to quartz monzonite of Gold Basin (Precambrian)

gb - Quartz diorite to quartz monzonite of Gold Basin (Precambrian)
Light-pinkish gray, medium-grained quartz diorite to quartz monzonite; variable in composition but typically about 65 percent sodic oligoclase, 2-5 percent microcline, 27 percent quartz, 7 percent biotite, and minor amounts of muscovite, epidote, hornblende, garnet, chlorite, apatite, and iron oxides. Description from source map: Iris NW Quadrangle

PCtp - Granite of Tolvar Peak (Precambrian)

tp - Granitic rocks, Granite of Tolvar Peak (Precambrian)
A light-gray, medium-grained, slightly porphyritic, microcline, albite (An 8-10), quartz, and sparse biotite. Description from source map: Gateview Quadrangle

tp - Granite of Tolvar Peak (Precambrian)
Very light gray, medium-grained granite having hypidiomorphic granular texture and sporadic subhedral quartz phenocrysts; commonly foliated parallel to east-west elongation of the stock; xenoliths of hornblende schist locally common. Description from source map: Powderhorn Quadrangle

PCgr - Granophyre (Precambrian)

gr - Granitic rocks, Granophyre (Precambrian)
Light-gray, medium-grained granophyre in small intrusive body near Goose Creek (NE corner, sec. 15, T.47N., R.3W).Description from source map: Gateview Quadrangle

Granite and Tonalite of South Beaver Creek

PCsbg - Granite and Tonalite of South Beaver Creek, granite to granodiorite (Precambrian)

sb - Granite of South Beaver Creek, granite to granodiorite (Precambrian)
Light-gray, medium-grained, xenomorphic granular rock; in order of abundance, contains sodic oligoclase (An 12-15), quartz, microcline, biotite, and accessory sphene, epidote, albanite, ferric oxides, and apatite. Elongate bodies and dikes are broadly concordant to the foliation, but cut across it in detail; probably syntectonically intruded during and shortly after regional metamorphism. Description from source map: Big Mesa Quadrangle

Xsb - Proterozoic Igneous Rocks, Tonalite of South Beaver Creek (Paleoproterozoic)
This unit contains light-gray to pink hornblende biotite tonalite, biotite trondhjemite and biotite granite with tonalite as the dominant rock type. The tonalite/trondhjemite has 50-60% plagioclase (An25-30), 20- 30% quartz, 5-10% biotite, and less than 5% hornblende and microcline. The granite has 40% plagioclase (An 25), 35% quartz, 30% microcline, and 3% biotite. Accessory minerals include magnetite, titanite, zircon, and apatite. The granite is cut by late-stage quartz-microcline pegmatite dikes and by prophyritic tonalite dikes as described by Vance (1984). Bickford and others (1989) report a conventional 207Pb/208Pb age on zircon of 1,721 ± 7 Ma from a sample at the Aberdeen Quarry on the adjacent Iris NW quadrangle. Hill and Bickford (2001) report a SHRIMP 207Pb/208Pb age of 1,700 Ma for homogeneous zircons and overgrowth rims from the same sample. These zircons have an inherited component with zircon cores as old as 2521 ± 14 Ma. Detailed petrography and geochemistry of these rocks is presented by Vance (1984) and Tobin (1982). These rocks are equivalent to the granite of South Beaver Creek of Hedlund (1974) and Hedlund and Olson (1974). Description from source map: Gunnison Quadrangle

sb - Granite of South Beaver Creek, granite to quartz monzonite, granodiorite, and quartz diorite (Precambrian)
Light gray to pinkish-gray, medium-grained; composition variable but approximately 32-48 percent oligoclase, 2-47 percent microcline, 20-35 percent quartz, 1-11 percent biotite, 0-3 percent hornblende, 0-1 percent epidote, 0.5 percent sphene, and accessory garnet, apatite, iron oxides, and chlorite. Contains many inclusions of migmatite and hornblende schist, the partial assimilation of which may account for rapid compositional changes in the granite. Synkinematic granite forming arcuate elongate bodies and irregular plugs and dikes in northwest quarter of the quadrangle.

Aberdeen quarry supplied granite for construction of Colorado State Capitol Building in 1889-92. Description from source map: Iris NW Quadrangle

sb and g - Granite of South Beaver Creek, biotite granite to biotite granodiorite (Precambrian)
The rock is light-grey with a medium grained, subhedral granular texture; in order of abundance, contains plagioclase, quartz, microcline, biotite, and accessory sphene, epidote allanite, ferric oxides, and apatite. Description from source map: McIntosh Mountain Quadrangle

PCsbp - Granite of South Beaver Creek, granite to quartz monzonite porphyry (Precambrian)

sbp - Granite of South Beaver Creek, granite to quartz monzonite porphyry (Precambrian)
Light-gray, to medium-grained to porphyritic rock containing scattered phenocrysts of perthitic microcline; essentially the same mineralogy as the nonporphyritic granite but generally microcline is the dominant feldspar and red garnet rather than sphene is the common accessory mineral. Shows various age relationships to the nonporphyritic granite (sb) but is nearly contemporaneous. Elongate bodies and dikes are broadly concordant to the foliation of the surrounding gneiss and schist. Description from source map: Big Mesa Quadrangle

sbp - Granite of South Beaver Creek, granite to quartz monzonite porphyry (Precambrian)
Light gray, medium-grained to porphyritic containing scattered phenocrysts of perthitic microcline; similar in mineral composition to the nonporphyritic granite but generally microcline is the dominant feldspar. Shows various age relationships to the non-porphyritic granite (sb) but is nearly contemporaneous. Description from source map: Iris NW Quadrangle

sbp – Granite of South Beaver Creek, granite porphyry (Precambrian)
Light-grey medium-grained biotite granite with scattered phenocrysts of microcline. Description from source map: McIntosh Mountain Quadrangle

PCqd - Quartz diorite (Precambrian)

qd - Quartz diorite (Precambrian)
Dark-gray, medium-grained dioritic rocks composed of 53-65 percent andesine or calcic oligoclase quartz, and minor amounts of chlorite, epidote, sphene, iron oxides, and apatite. Occurs in abut 50 smaller irregular intrusive bodies in the east half of the quadrangle; includes mostly metadiorite in the southeast quarter and younger nonmetamorphosed quartz diorite genetically related to the granite of South Beaver Creek in the northeast quarter. Contacts with enclosing rocks are commonly sharp, although contacts with porphyritic granite (sbp) in sec. 25, T.49N., R.2W. are gradational over an interval of a few feet. Description from source map: Big Mesa Quadrangle

qd - Quartz diorite (Precambrian)
Black to gray, medium-grained hornblende-quartz diorite to quartz monzonite; small plug-like bodies in Dubois Greenstone.Description from source map: Gateview Quadrangle

Xqd - Proterozoic Igneous Rocks, Quartz diorite (Paleoproterozoic)
This unit is a gray coarse-grained hornblende quartz diorite. The rock consists of 50-60% plagioclase (An30-45), 20-30% hornblende, less than 10% quartz, and less that 5% biotite and magnetite. Accessory minerals include titanite, zircon, and apatite. Bickford and others (1989) report a conventional 207Pb/208Pb age on zircon of 1,730 ± 6 Ma from a quartz diorite body in the adjacent Iris NW quadrangle. Detailed petrography and geochemistry of the quartz diorite is presented by

Vance (1984) and Tobin (1982).> Description from source map: Gunnison Quadrangle

qd - Diorite and quartz diorite (Precambrian)
Dark-gray medium-grained weakly gneissic diorite and quartz diorite; composition is approximately 43-60 percent sodic andesine, 25-38 percent hornblende, 3-10 percent quartz, 0-5 percent biotite, 3-5 percent chlorite, 2-3 percent iron oxides, and accessory sericite, apatite, and sphene. Chiefly occurs as irregular bodies associated with synkinematic granite of South Beaver Creek. Description from source map: Iris NW Quadrangle

qd - Quartz diorite (Precambrian)
Medium-gray, fine- to medium-grained quartz diorite; commonly contains 40-65 percent calcic oligoclase and sodic andesine (An 28-35), 20-40 percent hornblende, 2-5 percent biotite, 5-15 percent quartz, and accessory sphene, epidote, chlorite, apatite, and ferric oxides; texture xenomorphic granular to hypidiomorphic granular, locally weakly trachytic. The quartz diorite stock east of Milkranch Gulch is characterized by about 60 percent oligoclase, 15 percent aligned hornblende prisms, and 25 percent quartz. Description from source map: Powderhorn Quadrangle

PCm - Mica schist (Precambrian)

pCm - Mica schist (Precambrian)
Light- to medium-gray to silvery fine- to medium-grained commonly lineated quartz mica schist. Muscovite predominates over biotite. Grades into gneiss. Staurolite and andalusite coexist locally. Sillimanite abundant locally. Description from source map: Black Canyon of the Gunnison River and Vicinity

pCm - Mica schist (Precambrian)
Light- to medium-gray, fine- to medium-grained, strongly lineated quartz mica schist. Muscovite predominates over biotite. Grades locally into gneiss. Description from source map: Black Ridge Quadrangle

PCsgm - Metamorphic rocks, schist, gneiss and/or migmatite (Precambrian)

s - Metamorphic rocks, quartz-biotite schist and gneiss, and migmatite (Precambrian)
Gray, fine-grained, moderately foliated; locally finely layered with biotite-rich laminae alternating with more quartzose and sericitic laminae. Thin discontinuous conglomeratic beds are present in sec. 18 T.48N., R.1W. Quartz-biotite schist is chiefly in the southwest quarter of the quadrangle; elsewhere the schist is migmatized or grades into quartzo-feldspathic gneiss. Schist consists of a granoblastic groundmass of quartz, microcline, and poorly twinned albite-oligoclase (An 8-13) through which are aligned biotite plates; accessory minerals include muscovite, sphene, red garnet, epidote, blue-green hornblende, and apatite. Description from source map: Big Mesa Quadrangle

pCgm - Migmatitic gneiss (Precambrian)
Light- to medium-gray well-foliated, locally contorted and lineated, medium- to coarse-grained micaceous quartzo-feldspathic para-gneiss commonly containing abundant lenses or layers of granitic material, pegmatite, and quartz. Garnet and sillimanite are abundant locally. Radiometric metamorphic age based on a whole-rock rubidium-strontium isochron is 1700+/-70 million years. Description from source map: Black Canyon of the Gunnison River and Vicinity

pCgm - Migmatitic gneiss (Precambrian)
Light- to medium-gray well-foliated, locally contorted and lineated, medium- to coarse-grained micaceous quartzo-feldspathic paragneiss commonly containing abundant lenses or layers of granitic material, pegmatite, and quartz. Garnet and sillimanite are abundant locally, especially at Crystal Creek. Description from source map: Black Ridge Quadrangle

b - Black Canyon Schist, quartz-biotite schist and gneiss and some quartzo-feldspathic schist (Precambrian)
Light- to dark-gray; composed of quartz and feldspar, commonly 10-30 percent biotite, and minor muscovite and iron oxides. Represents metamorphosed fine-grained, generally thinly layered sedimentary rocks. Quartzo-feldspathic and related quartz-sericite schists occur locally in southern part of quadrangle and represent metamorphosed feldspathic sediments together with some probable admixture of felsic volcanic or tuffaceous material. North of 38°25' latitude the formation is mostly medium- to coarse-grained quartz-biotite gneiss and migmatite, containing streaks and lenses of quartz and feldspar, and commonly having ptygmatically folded or crenulated foliation. Description from source map: Carpenter Ridge Quadrangle

b - Black Canyon Schist, quartz biotite schist (Precambrian)
Light- to dark-gray, fine-grained, composed of quartz, feldspar, 10-30 percent biotite, minor muscovite, and iron oxides. Represents metamorphosed fine-grained sedimentary rocks. Description from source map: Gateview Quadrangle

Xs - Proterozoic Metamorphic Rocks, Biotite quartz schist (Paleoproterozoic)
This unit is predominantly a dark-gray fine- grained biotite quartz schist but also contains dark-gray biotite quartz gneiss, dark-gray biotite quartzite, and light-gray to pink feldspathic quartzite. Migmatitic gneiss with ptygmaitcally folded quartz-rich leucosomes are common near the margins of the tonalite of South Beaver Creek. The biotite-bearing units are dominated by granoblastic quartz, microcline, and plagioclase (albite-oligoclase) with variable amounts (5-50%) of aligned biotite to produce the foliation. Accessory minerals include muscovite, epidote, blue- green hornblende, titanite, and apatite. The feldspathic quartzites contain granoblastic quartz, microcline, and plagioclase (albite-oligoclase) and rare garnet metacrysts that are limited to a few isolated outcrops in the southwest corner of the quadrangle. These rocks are equivalent to the quartz-biotite schist of Hedlund (1974), Hedlund and Olson (1974), and Olson (1976b), and the biotite schist of Tobin (1982). Description from source map: Gunnison Quadrangle

s - Metamorphic rocks, quartz-biotite schist and gneiss, and migmatite (Precambrian)
Gray, fine-grained moderately foliated schist containing quartz, disseminated and aligned biotite plates, microcline, and albite-oligoclase; accessory minerals include epidote, muscovite, garnet, hornblende, and apatite; migmatitic and gneissic within areas of synkinematic granite; relict clastic textures common in less metamorphosed beds, which are thinly laminated to massive; thin conglomeratic beds locally present. Description from source map: Iris NW Quadrangle

pCs - Metamorphic rocks, quartz-biotite schist and gneiss (Precambrian)
The rock is grey, fine-grained, moderately foliated; locally gneissic with fine biotite-rich laminae alternating with more quartzo-feldspathic laminae. Description from source map: McIntosh Mountain Quadrangle

s - Quartz-biotite schist (Precambrian)
Light- to dark-gray, fine-grained schist, granoblastic groundmass of anhedral quartz, microcline, and oligoclase (An 12-28) with aligned biotite and muscovite plates; some laminae contain as much as 30 percent biotite; red garnet common accessory mineral. Represents metamorphosed sandstone and finer grained sediment; in places lenses of quartz-calcite-sericite-epidote gneiss represent interbedded limy sandstone. Description from source map: Powderhorn Quadrangle

PCgl - Layered quartzitic gneiss (Precambrian)

pCgl - Layered quartzitic gneiss (Precambrian)
Medium- to dark-gray mostly fine grained quartzitic paragneiss or metaquartzite, commonly lineated and locally contorted. Conspicuous layering coincides with bedding. Grades into massive quartzitic gneiss and mica schist. Description from source map: Black Canyon of the Gunnison River and

Vicinity

pCgl - Layered quartzitic gneiss (Precambrian)
Medium- to dark-gray mostly fine-grained quartzitic paragneiss or metaquartzite, commonly lineated and locally contorted. In places contains massive weakly foliated metaquartzite. Grades into mica schist. Conspicuous layering coincides with bedding. Description from source map: Black Ridge Quadrangle

PCbt - Quartz-biotite gneiss and migmatite (Precambrian)

bt - Black Canyon Schist, quartz-biotite gneiss and migmatite (Precambrian)
Gray, medium- to coarse-grained, containing streaks and lenses of quartz and feldspar, and commonly having ptygmatically folded or crenulated foliation. Description from source map: Gateview Quadrangle

PCa - Amphibolite (Precambrian)

a - Metamorphic rocks, amphibolite (Precambrian)
Black to greenish black, medium-grained, gneissic; contains blue-green hornblende, about 25-30 percent andesine (An 35-45), and generally less than 5 percent quartz; accessory minerals include chlorite, epidote, sphene, biotite, and apatite. Occurs as discontinuous elongate bodies parallel to the foliation of the surrounding quartz-biotite schist. Original rock may have been a volcanic basalt, andesite, or mafic intrusive of basaltic composition. Description from source map: Big Mesa Quadrangle

pCa - Amphibolite (Precambrian)
Dark-gray to black commonly lineated medium-to coarse-grained schist consisting chiefly of hornblende and plagioclase with subordinate biotite, quartz, sphene, epidote, apatite, and zircon. Some specimens contain abundant diopside and microcline. Many bodies probably larger than shown on map. As mapped, includes bodies of greenstone and metadiorite. Description from source map: Black Canyon of the Gunnison River and Vicinity

pCa - Amphibolite (Precambrian)
Dark-gray to black well-foliated commonly lineated medium- to coarse-grained schist consisting chiefly of hornblende and plagioclase with subordinate biotite, quartz, sphene, epidote, apatite, and zircon. Some specimens contain abundant diopside and microcline. Description from source map: Black Ridge Quadrangle

bh - Black Canyon Schist, amphibolite and hornblende schist (Precambrian)
Black to greenish-black, fine- to medium-grained rocks composed of hornblende and andesine and accessory quartz, biotite, chlorite, clinozoisite, calcite, sphene, apatite, and iron oxides. Locally rich in epidote. Probably largely of metasedimentary origin but may include metaigneous rocks also. Description from source map: Carpenter Ridge Quadrangle

bh - Black Canyon Schist, amphibolite and hornblende schist (Precambrian)
Black to greenish-black, fine- to medium-grained rocks composed of hornblende, andesine, and accessory quartz, biotite, chlorite, epidote, clinozoisite, calcite, sphene, apatite, and iron oxides. Probably largely of meta-sedimentary origin, but may include mafic to intermediate flows and tuffs. Description from source map: Gateview Quadrangle

Xa - Proterozoic Metamorphic Rocks, Amphibolite (Paleoproterozoic)
This unit is a black to greenish-black fine- to medium-grained amphibolite. The amphibolite is weakly foliated in most places but grades into gneissic structures locally. The amphibolite consists of 35-70%

green amphibole, 25-50% plagioclase (andesine An30-45), and smaller amounts of quartz (<5%), chlorite, epidote, biotite, titanite, and apatite. Amphibolites are often cut by quartz or epidote veins. These rocks are equivalent to the amphibolite and hornblende schist of Hedlund (1974), Hedlund and Olson (1974), and Olson (1976b), the amphibolite of Tobin (1982), and the amphibolite and fine-grained hornblende diorite of Vance (1984). Description from source map: Gunnison Quadrangle

a - Metamorphic rocks, amphibolite (Precambrian)
Black to greenish-black, medium-grained, contains blue-green hornblende, 23-55 percent partly saussuritized andesine (An 30-36), and accessory chlorite, clinozoisite, biotite, sphene, apatite, calcite, and iron oxides. Occurs as elongate contorted lenses that were sills or flows of basaltic or andesitic composition. Description from source map: Iris NW Quadrangle

a - Amphibolite (Precambrian)
The rock is black to greenish black, medium grained with a granoblastic to gneissic texture; contains hornblende and plagioclase with only minor amounts of quartz; accessory minerals include chlorite, epidote, sphene, biotite, and apatite. Description from source maps: Little Soap Park Quadrangle and McIntosh Mountain Quadrangle

PCgq - Massive quartzitic gneiss, and schist and gneiss (Precambrian)

pCgq - Massive quartzitic gneiss (Precambrian)
Light- to medium-gray mostly fine-grained saccharoidal crystalloblastic to weakly foliated very thickly bedded paragneiss consisting of >50 percent quartz, <40 percent albite or oligoclase, <30 percent microcline, <15 percent biotite, and subordinate muscovite, garnet, apatite, sphene, epidote, hematite, and zircon. Contains local interbeds of mica schist, amphibolite, strongly foliated gneiss, and rare metaconglomerate (?). Description from source map: Black Canyon of the Gunnison River and Vicinity

pCs - Schist and gneiss, undivided (Precambrian)
Pale yellowish-brown to olive-black; includes some irregular bodies of amphibolite. Predominant minerals quartz, plagioclase, microcline, biotite, muscovite, and amphibole. Description from source map: Cerro Summit Quadrangle

PCf - Quartzo-feldspathic gneiss (Precambrian)

f - Metamorphic rocks, quartzo-feldspathic gneiss (Precambrian)
Light-gray, fine-grained, granoblastic groundmass containing scattered clasts of albite-oligoclase as much as 4 mm across; granoblastic groundmass consists of anhedral quartz, perthitic microcline, and poorly twinned albite-oligoclase (An 8-15). Aligned muscovite plates locally constitute 15 percent of the gneiss and generally exceed biotite in amount; angular feldspar clasts in association with eutaxitic-like groundmass suggest the local presence of metatuffaceous rocks. Gradational contacts with quartz-biotite schist and gneiss. Description from source map: Big Mesa Quadrangle

f - Metamorphic rocks, quartzofeldspathic gneiss (Precambrian)
Light to medium gray, fine-grained, characterized by locally abundant grains of albite-oligoclase as much as 4 mm across in a microcrystalline to granoblastic groundmass of granular quartz, microcline, and oligoclase. The feldspar fragments, relict eutaxitic texture of the groundmass, and local presence of devitrified and recrystallized pumice lapilli suggest that parts are of volcanic origin; accessory minerals include muscovite, epidote, biotite, and iron oxides. Description from source map: Iris NW Quadrangle

PCqf - Quartzo-feldspathic and quartz-sericite schist (Precambrian)

bqf - Black Canyon Schist, quartzo-feldspathic and quartz-sericite schist (Precambrian)
Composed of microcline, albite, quartz, biotite, muscovite, and accessory apatite, garnet, iron oxides, and clinozoisite. Represents metamorphosed feldspathic sediments with admixture in some places of felsic volcanic or tuffaceous material. A few thin beds are conglomeratic, and metachert is interbedded locally. Description from source map: Gateview Quadrangle

qf - Quartzofeldspathic and quartz-sericite schist (Precambrian)
Light-gray, fine-grained, granoblastic-textured schist; consists of quartz, microcline, oligoclase, sericite, biotite, and accessory apatite, garnet, iron oxides, and clinozoisite. Represents metamorphosed feldspathic sediments and minor interbeds of felsic volcanic or tuffaceous material; locally includes metaconglomerate and quartzite. Description from source map: Powderhorn Quadrangle

PCbq - Quartzite and quartz-sericite schist (Precambrian)

bq - Black Canyon Schist, gray to purplish-gray quartzite (Precambrian)
Contains finely disseminated magnetite; inferred to be metamorphosed siliceous or cherty beds; present in sec. 27, T.48N., R.3W. Description from source map: Carpenter Ridge Quadrangle

bq - Black Canyon Schist, quarzite and quartz-sericite schist (Precambrian)
Gray to purplish-gray. Description from source map: Gateview Quadrangle

PCqt - Quartzite (metachert?) (Precambrian)

qt - Metamorphic rocks, quartzite (metachert?) (Precambrian)
Gray to brownish- or purplish-gray quartzite. Beds commonly 1-20 feet thick. Description from source map: Big Mesa Quadrangle

qt - Metamorphic rocks, quartzite beds (Precambrian)
Purplish-gray to brownish-gray, composed chiefly of quartz but locally contain finely disseminated magnetite. Beds were probably chert and are generally less than 20 feet thick. Description from source map: Iris NW Quadrangle

PCh - Hornblende schist and amphibolite (Precambrian)

h - Metamorphic rocks, hornblende schist containing minor amphibolite (Precambrian)
Dark greenish black, fine-grained; generally contains less than 20 percent plagioclase and 70-90 percent blue-green hornblende, accessory minerals include chlorite, biotite, and quartz. Chiefly crops out in the southeast quarter of the quadrangle as highly irregular disrupted bodies. Locally contains amygdules and relict pillow structures which indicate a volcanic origin. Description from source map: Big Mesa Quadrangle

h - Metamorphic rocks, hornblende schist containing minor amphibolite (Precambrian)
Dark greenish-black, fine-grained, contains 50-75 percent hornblende partly altered to chlorite, about 25 percent or less andesine (An 32-38), and accessory biotite, calcite, chlorite, and iron oxides; elongation of lenticular bodies parallel to bedding. Amygdules, breccia, and local pillow structures indicate volcanic origin. Description from source map: Iris NW Quadrangle

h - Amphibolite and hornblende schist (Precambrian)

Black to greenish-black, fine- to medium-grained rocks consisting of hornblende, andesine, and accessory quartz, biotite, chlorite, epidote, clinozoisite, calcite, sphene, apatite, and iron oxides. Interlayered with metasediments and may include hornblendic rocks of both sedimentary and volcanic origin. Description from source map: Powderhorn Quadrangle

Dubois Greenstone

PCdh - Dubois Greenstone, hornblende schist and amphibolite (Precambrian)

dh - Metamorphic rocks, Dubois Greenstone (Precambrian)
Dark-green to black, fine-grained hornblende schist and amphibolite; consists of 60-75 percent blue-green hornblende, 20-30 percent partially saussuritized oligoclase-andesine (An 28-37), less than 10 percent quartz, and accessory sphene, epidote, and ferric oxides. Amygdules, phenocrysts, and pillow structures indicative of volcanic origin locally present within the formation in adjacent quadrangles. Crops out along Camp Creek and is part of a larger outcrop area in the Powderhorn quadrangle to the south. Differs from the other hornblende schist and gneiss in that it is commonly interlayered with felsite and felsite porphyry rather than quartz-biotite schist. Description from source map: Big Mesa Quadrangle

dh - Dubois Greenstone, metavolcanic hornblende schist and amphibolite (Precambrian)
Dark-green to black, fine-grained hornblende schist and amphibolite, largely of volcanic origin: represents metamorphosed basaltic to dacitic flows, breccias, and possibly tuffs. Occurs near southern boundary of quadrangle in small area which is northern tip of a large exposure in the Gateview quadrangle. Description from source map: Carpenter Ridge Quadrangle

dh - Dubois Greenstone, metavolcanic hornblende schist and amphibolite (Precambrian)
Dark-green to black, fine-grained hornblende and chlorite-hornblende schist and fine- to medium-grained amphibolite largely of volcanic origin; amygdules, phenocrysts, and pillow structures locally present. Represents metamorphosed basaltic to dacitic flows, breccias, probably tuffs and minor dike rocks. Description from source map: Gateview Quadrangle

dh - Metamorphic rocks, Dubois Greenstone (Precambrian)
Dark-greenish-black, fine-grained hornblende schist and amphibolite; largely of volcanic origin, represents metamorphosed basaltic to dacitic flows, breccia, and possibly tuffs. Main Dubois Greenstone outcrop is located in Spring Hill Creek and Powderhorn quadrangles to the south. Description from source map: Iris NW Quadrangle

dh - Dubois Greenstone, hornblende schist and amphibolite (Precambrian)
Greenish-black, fine- to coarse-grained rock, consists of about 50-70 percent blue-green hornblende ($N\gamma$ = 1.675-1.680), 20-30 percent andesine (An 38-47) that is weakly saussuritized, varying amounts of chlorite-as much as 10 percent-and accessory quartz, sericite, epidote, sphene, biotite, calcite, and iron oxides; relict plagioclase phenocrysts are locally as much as 2 cm long; sparse amygdaloidal texture and pillow structure indicative volcanic origin; original rock probably andesite lavas, sills, and dikes. Description from source map: Powderhorn Quadrangle

PCds - Dubois Greenstone, quartzite and quartz-sericite schist (Precambrian)

dqs - Dubois Greenstone, quartz-sericite schist and quartzite (Precambrian)
In beds interlayered with the hornblende schist and amphibolite of dh unit. Description from source map: Carpenter Ridge Quadrangle

ds - Dubois Greenstone, interlayered greenstone and metasedimentary rocks (Precambrian)
Hornblende schist, calcareous hornblende-chlorite schist, calcite-quartz-biotite schist, quartz-epidote

schist, thin quartzite beds, metasiltstone, and some amygdaloidal hornblendic flow rocks; unit probably represents interlayered sedimentary, tuffaceous, and metavolcanic rocks. Description from source map: Gateview Quadrangle

ds - Dubois Greenstone, quartzite and quartz-sericite schist (Precambrian)
Light-gray, fine-grained, quartzose metasedimentary rocks as lenses within Dubois Greenstone; may be tuffaceous in part. Description from source map: Powderhorn Quadrangle

PCdq - Dubois Greenstone, quartzite (Precambrian)

dq - Dubois Greenstone, quartzite beds (metachert) (Precambrian)
Commonly purplish-gray and containing finely disseminated magnetite; inferred to be metamorphosed chert beds interlayered with other units. Description from source map: Gateview Quadrangle

dq - Dubois Greenstone, quartzite (Precambrian)
Quartzite-Purplish-gray to gray, fine-grained, granoblastic-textured quartzite; predominantly quartz with minor amounts of epidote, disseminated magnetite, and sericite. Inferred to have originated as chert beds. Description from source map: Powderhorn Quadrangle

PCdb - Dubios Greenstone, quartz-biotite-calcite schist (Precambrian)

db - Dubois Greenstone, quartz-biotite-calcite schist (Precambrian)
Occurs as thin, discontinuous beds interlayered with hornblende schist and metachert. Description from source map: Gateview Quadrangle

PCdag - Dubois Greenstone, amphibolite-granite hybrid rock of Carpenter Gulch (Precambrian)

dag - Dubois Greenstone, amphibolite-granite hybrid rock of Carpenter Gulch (Precambrian)
Medium-grained amphibolite, probably of igneous origin, brecciated in places and commonly intruded by many dikes and fracture fillings of granite. Description from source map: Gateview Quadrangle

PCdf - Dubois Greenstone, felsite and felsite porphyry (Precambrian)

df - Dubois Greenstone, interlayered felsic volcanics and metasedimentary rocks (Precambrian)
Interlayered felsic volcanics and metasedimentary rocks: white to gray felsite, commonly porphyritic, interlayered with amphibolite and chlorite schist of dh unit, metamorphosed tuffaceous beds, and aluminous metasedimentary schist containing quartz, biotite, staurolite, kyanite, andalusite, and garnet. The porphyritic felsite is characterized by phenocrysts of quartz, oligoclase or albite, and orthoclase in a microcrystalline groundmass of granular oligoclase, quartz, and sparse biotite, and hornblende. The felsite and quartz porphyry in this unit are inferred to be volcanic origin as flows, tuffs, and dikes of dacite, rhyodacite, quartz latitite, and rhyolite, in places metamorphosed to quartz-sericite and quartz-chlorite schist. The df unit consists chiefly of felsite and quartz porphyry east and south of Tolvar Peak; these layers north and northeast of Tolvar Peak; many of the sheet-like bodies of felsite and quartz porphyry northwest of Tolvar Peak in secs. 13 and 14, T.47N., R.3W., are probably dikes. Description from source map: Gateview Quadrangle

df - Dubois Greenstone, felsite and felsite porphyry (Precambrian)
Felsite and felsite porphyry-Light-gray, metamorphosed rhyolite, quartz latite, and tuffaceous sedimentary rocks characterized by phenocrysts of oligoclase, and sparse biotite and hornblende. In

places, as within 1 mile of Vulcan, highly sheared, metamorphosed, and hydrothermally altered to quartz-chlorite and laminated quartz-sericite schist containing as much as 50 percent sericite. Meta-sedimentary layers near Ute Trail mine contain metacrysts of andalusite (?) replaced by sericite. Description from source map: Powderhorn Quadrangle

PCdc - Dubois Greenstone, quartzite conglomerate (Precambrian)

dc - Dubois Greenstone, quartzite conglomerate (Precambrian)
Composed of rounded pebbles and cobbles of white to gray quartz cemented by fine-grained quartz. Description from source map: Gateview Quadrangle

PCda - Dubois Greenstone, coarse-grained amphibolite, metadiortie, and metagabbro (Precambrian)

da - Dubois Greenstone, coarse-grained amphibolite, metadiorite, and metagabbro (Precambrian)
Black, gneissic amphibolite, hornblende-plagioclase gneiss, hornblendite, metadiorite, and metagabbro that probably represent mafic intrusive rocks; may include some metavolcanic rocks of basaltic to andesitic composition. Description from source map: Gateview Quadrangle

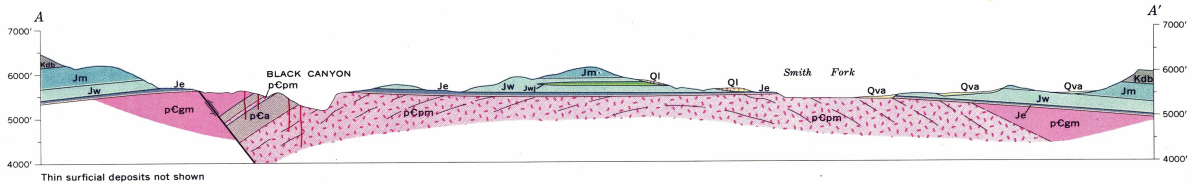
fault zone (age indeterminable)

Wide shear zones. Description from source map: Black Canyon of the Gunnison River and Vicinity

Geologic Cross Sections

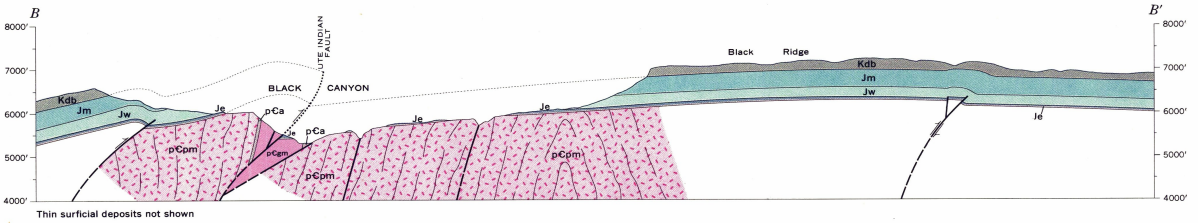
The geologic cross sections present in the GRI digital geologic-GIS data produced for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, Colorado (BLCA-CURE) are presented below. Note that nearly all cross section abbreviations (e.g., A - A') may have been changed from their source map abbreviation in the GRI data so that each cross section abbreviation in the GRI data is unique. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



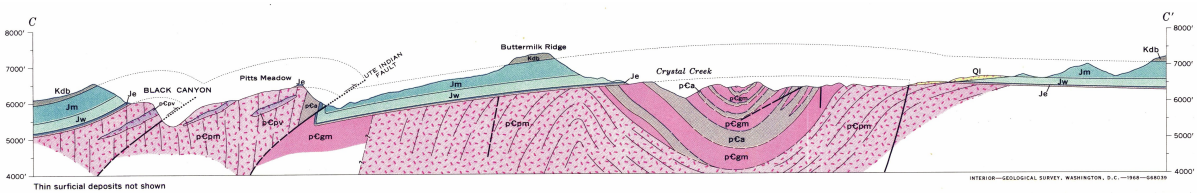
Graphic from: Black Ridge Quadrangle. No vertical exaggeration indicated on source map.

Cross Section B-B'



Graphic from: Black Ridge Quadrangle. No vertical exaggeration indicated on source map.

Cross Section C-C'

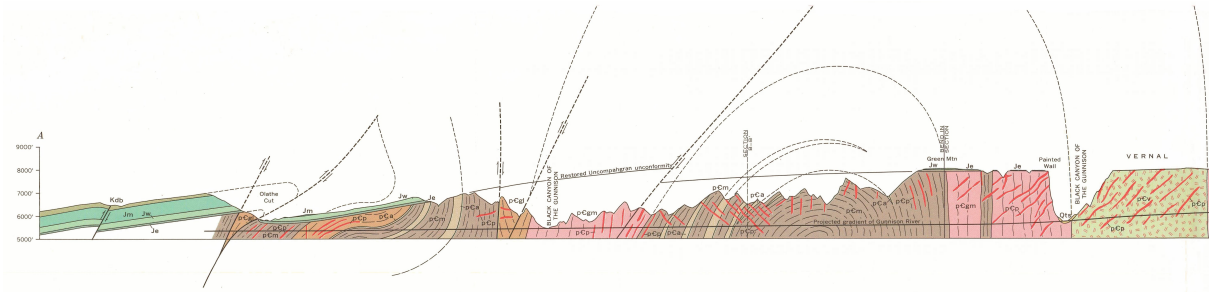


Graphic from: Black Ridge Quadrangle. No vertical exaggeration indicated on source map.

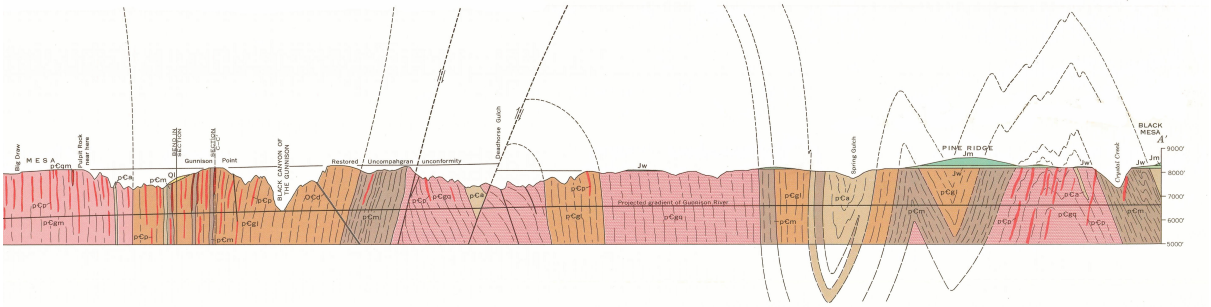
Cross Section D-D'

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Start of cross section D-D'.

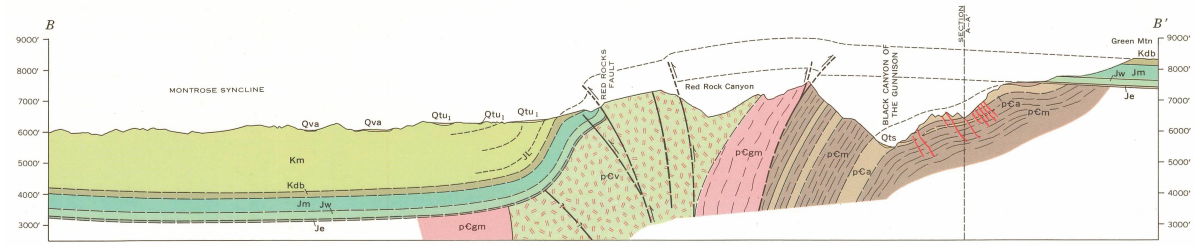


Continuation of cross section D-D'.



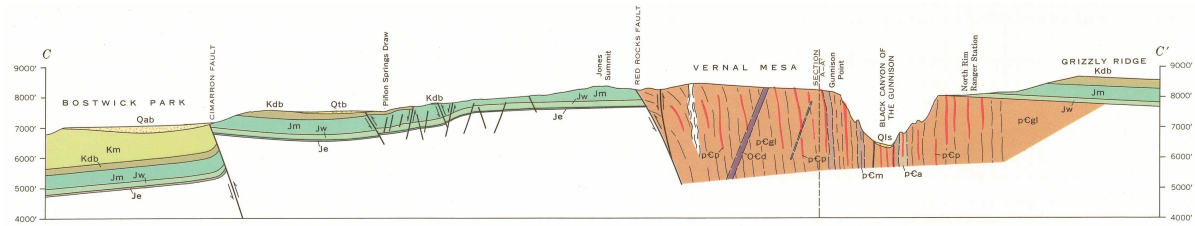
Graphic from: Black Canyon of the Gunnison River and Vicinity. Cross section abbreviation A-A' on source map. No vertical exaggeration indicated on source map.

Cross Section E-E'



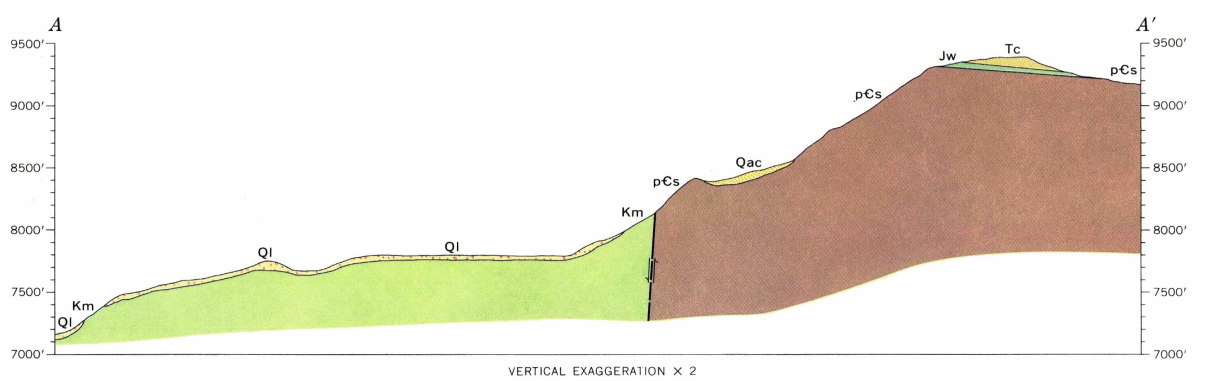
Graphic from: Black Canyon of the Gunnison River and Vicinity. Cross section abbreviation B-B'' on source map. No vertical exaggeration indicated on source map.

Cross Section F-F'



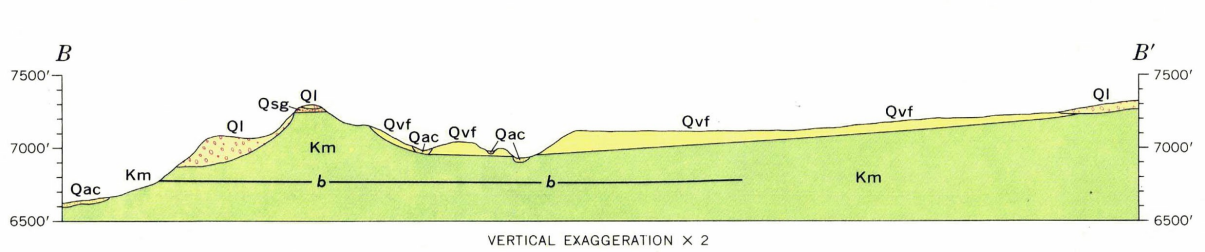
Graphic from: Black Canyon of the Gunnison River and Vicinity. Cross section abbreviation C-C' on source map. No vertical exaggeration indicated on source map.

Cross Section G-G'



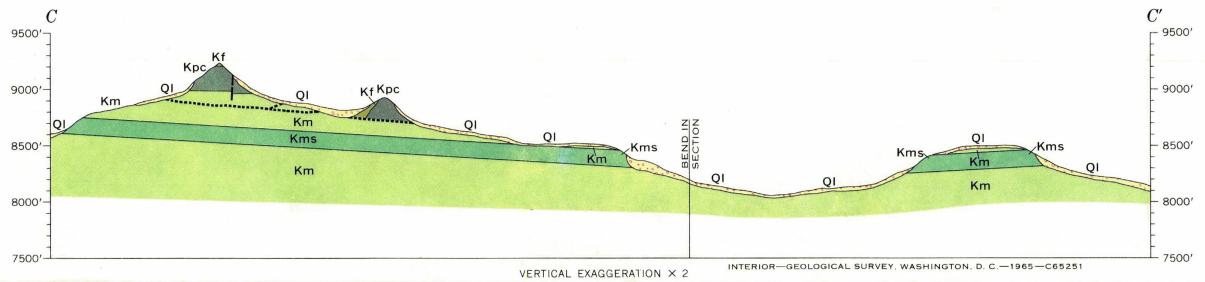
Graphic from: Cerro Summit Quadrangle. Cross section abbreviation A-A' on source map. No vertical exaggeration indicated on source map.

Cross Section H-H'



Graphic from: Cerro Summit Quadrangle. Cross section abbreviation B-B' on source map. No vertical exaggeration indicated on source map.

Cross Section I-I'

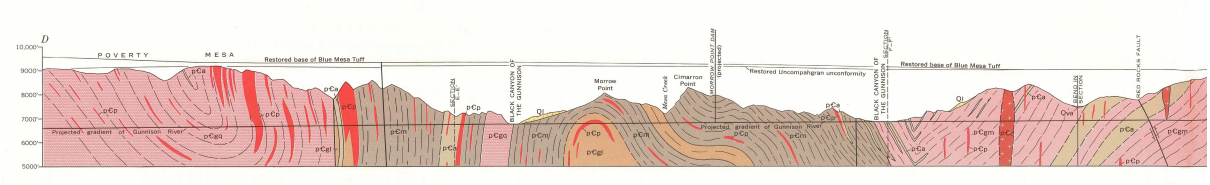


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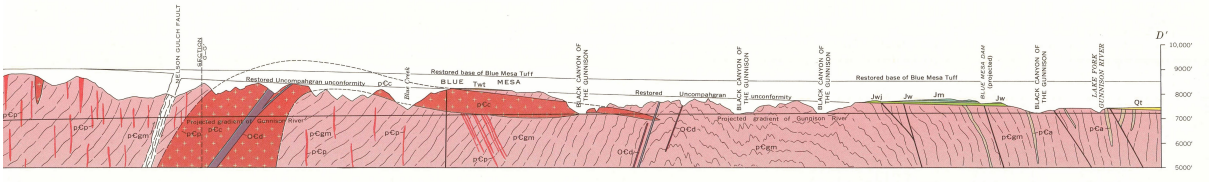
Cross Section J-J'

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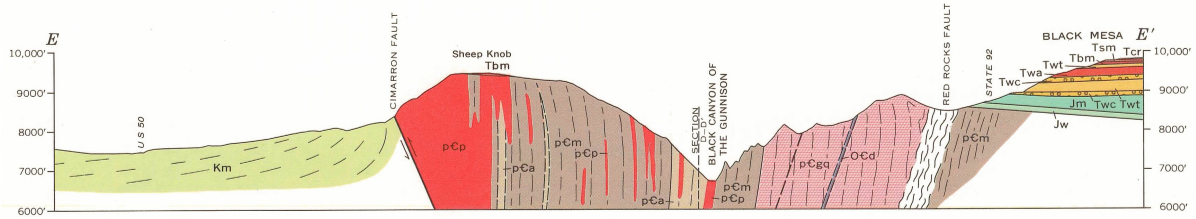


Continuation of cross section J-J'.



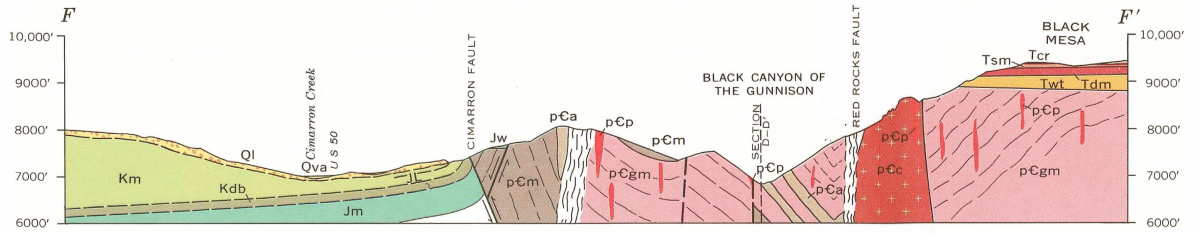
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Cross Section K-K'



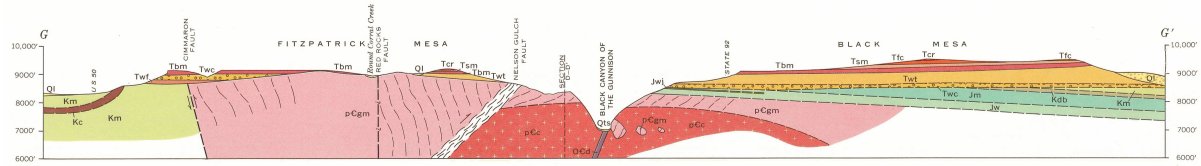
Graphic from: Black Canyon of the Gunnison River and Vicinity. Cross section abbreviation E-E' on source map. No vertical exaggeration indicated on source map.

Cross Section L-L'



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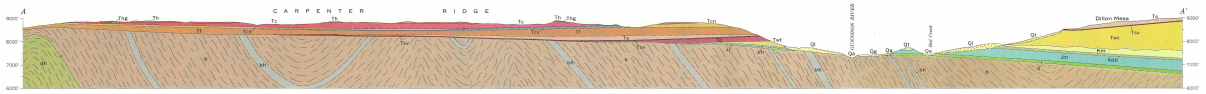
Cross Section M-M'



Graphic from: Black Canyon of the Gunnison River and Vicinity. Cross section abbreviation G-G' on

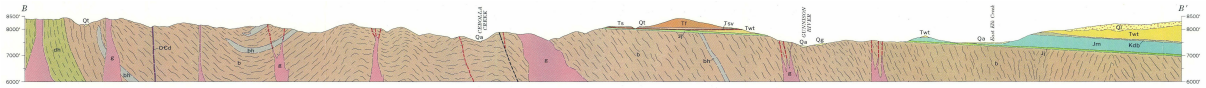
source map. No vertical exaggeration indicated on source map.

Cross Section N-N'



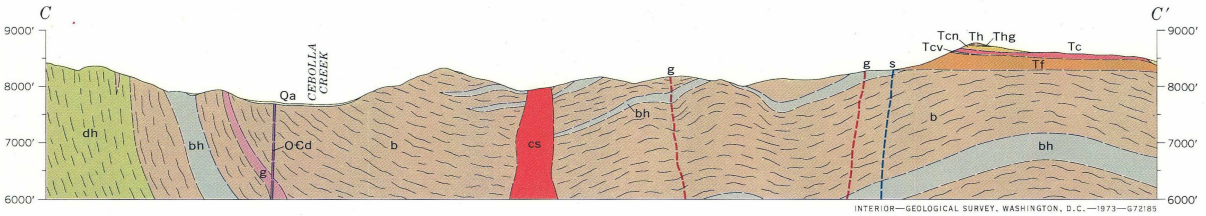
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Cross Section O-O'



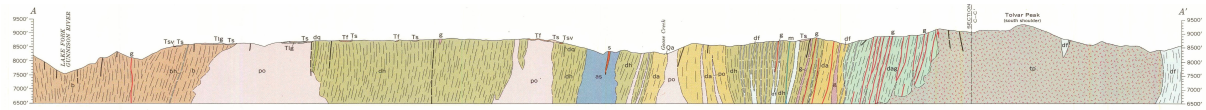
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Cross Section P-P'



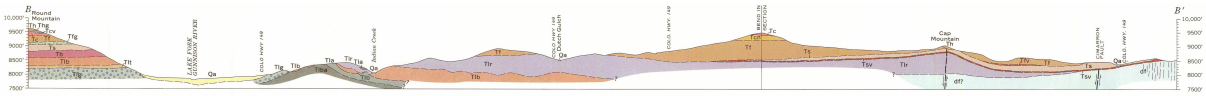
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Cross Section Q-Q'



Graphic from: Gateview Quadrangle. Cross section abbreviation A-A' on source map. No vertical exaggeration indicated on source map.

Cross Section R-R'



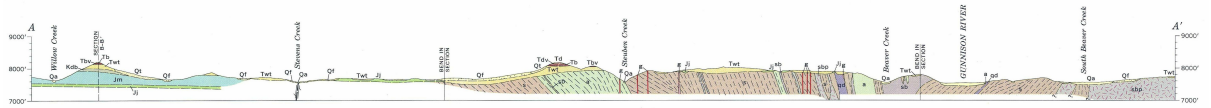
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Cross Section S-S'



Graphic from: Gateview Quadrangle. Cross section abbreviation C-C' on source map. No vertical exaggeration indicated on source map.

Cross Section T-T'



Graphic from: Big Mesa Quadrangle. Cross section abbreviation A-A' on source map. No vertical exaggeration indicated on source map.

Cross Section U-U'



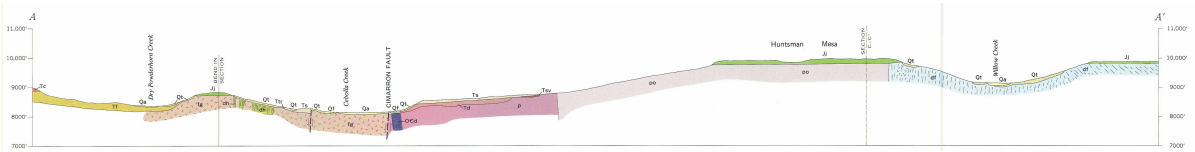
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Cross Section V-V'



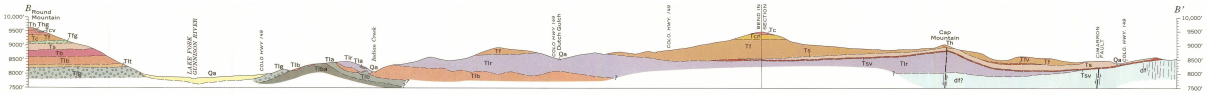
Graphic from: Big Mesa Quadrangle. Cross section abbreviation C-C' on source map. No vertical exaggeration indicated on source map.

Cross Section W-W'



Graphic from: Powderhorn Quadrangle. Cross section abbreviation A-A' on source map. No vertical exaggeration indicated on source map.

Cross Section X-X'

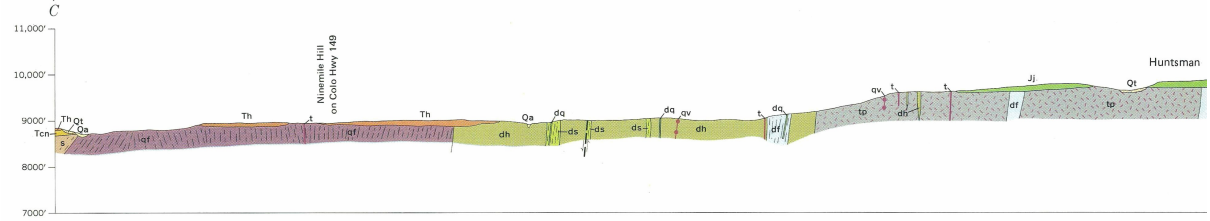


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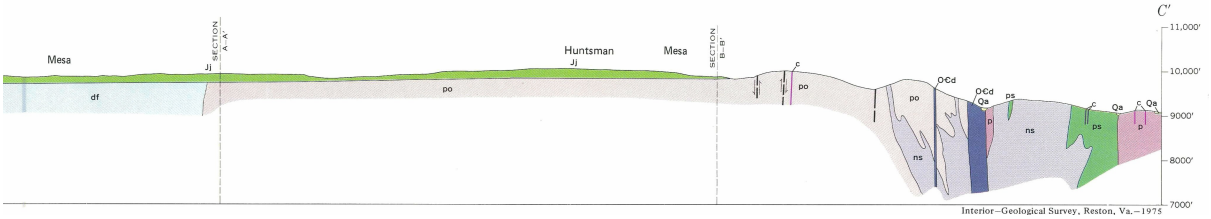
Cross Section Y-Y'

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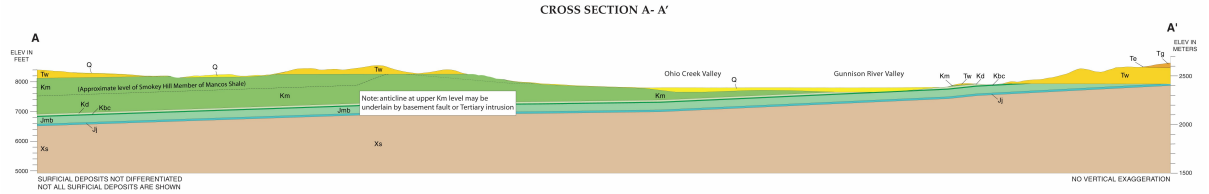


Continuation of cross section Y-Y'.



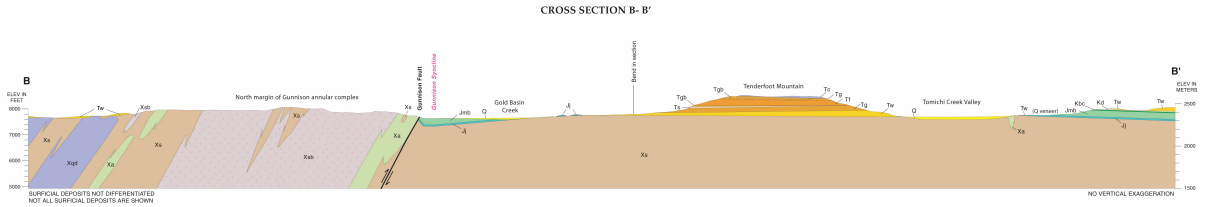
Graphic from: Powderhorn Quadrangle. Cross section abbreviation C-C' on source map. No vertical exaggeration indicated on source map.

Cross Section Z-Z'



Graphic from: Gunnison Quadrangle. Cross section abbreviation A-A' on source map. No vertical exaggeration indicated on source map.

Cross Section AA-AA'

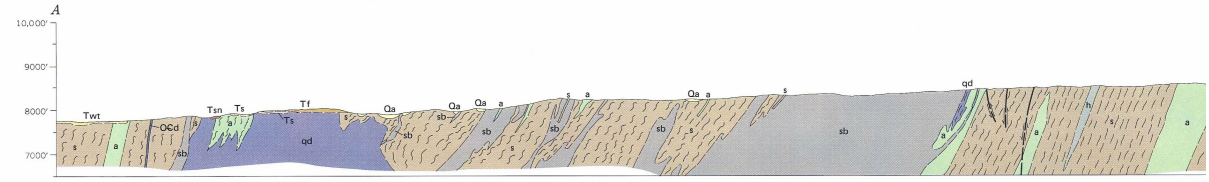


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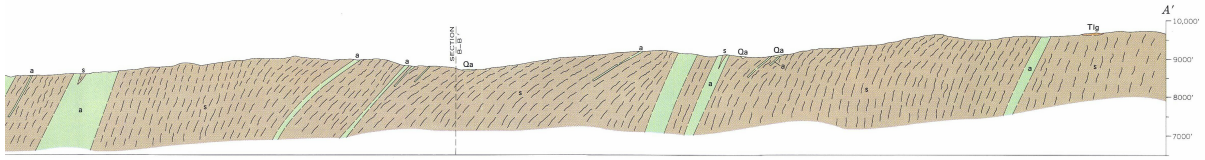
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Continuation of cross section BB-BB'.

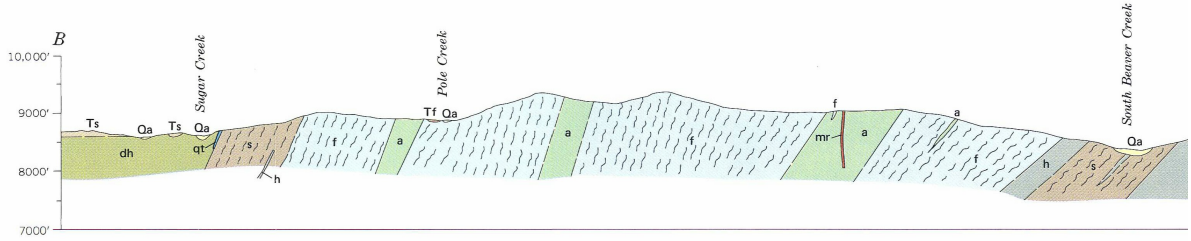


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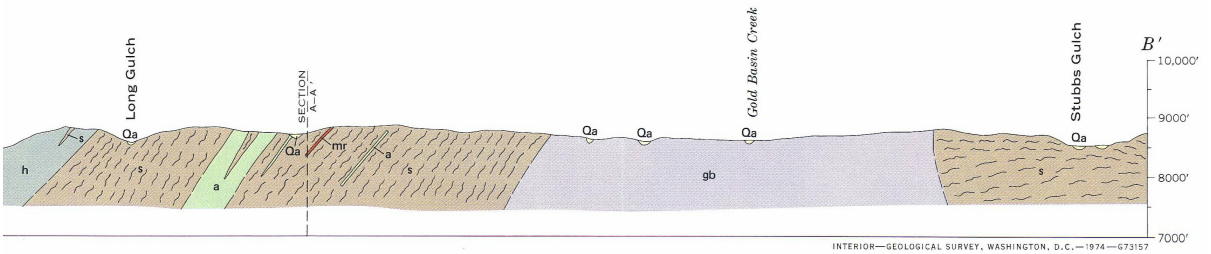
Cross Section CC-CC'

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Start of cross section CC-CC'.



Continuation of cross section CC-CC'.



Graphic from: Iris NW Quadrangle. Cross section abbreviation B-B' on source map. No vertical exaggeration indicated on source map.

Ancillary Source Map Information

The following section present ancillary source map information associated with source used for this project.

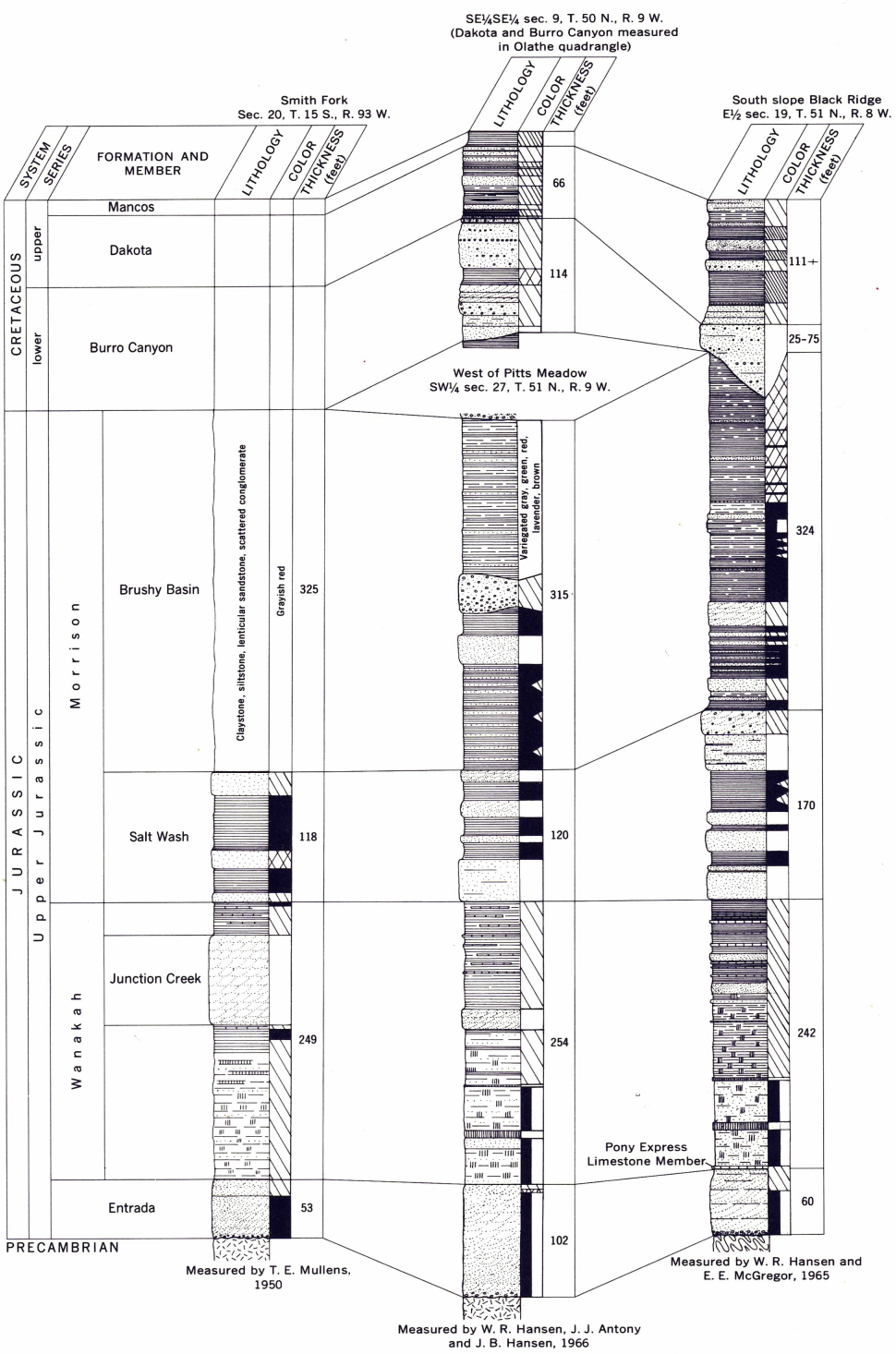
Black Ridge Quadrangle

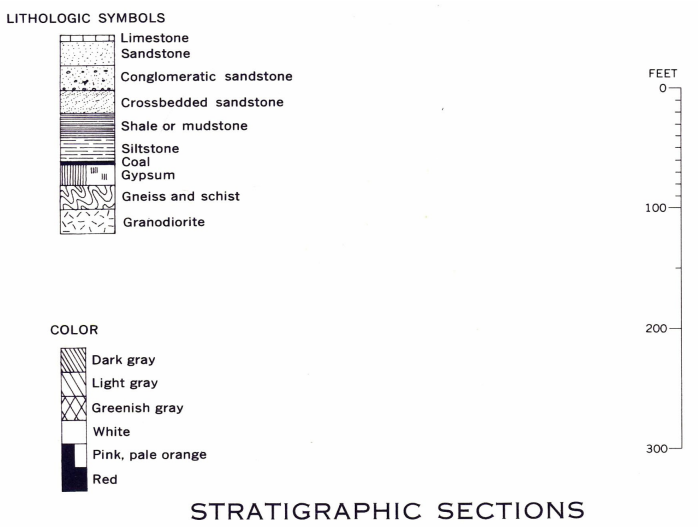
The formal citation for this source.

Hansen, W.R., 1968, Geologic Map of the Black Ridge Quadrangle, Delta and Montrose Counties, Colorado: U.S. Geological Survey, Geological Quadrangle Map, GQ-747, scale 1:24,000 (*GRI Source Map ID 1*).

Prominent graphics and text associated with this source are presented below.

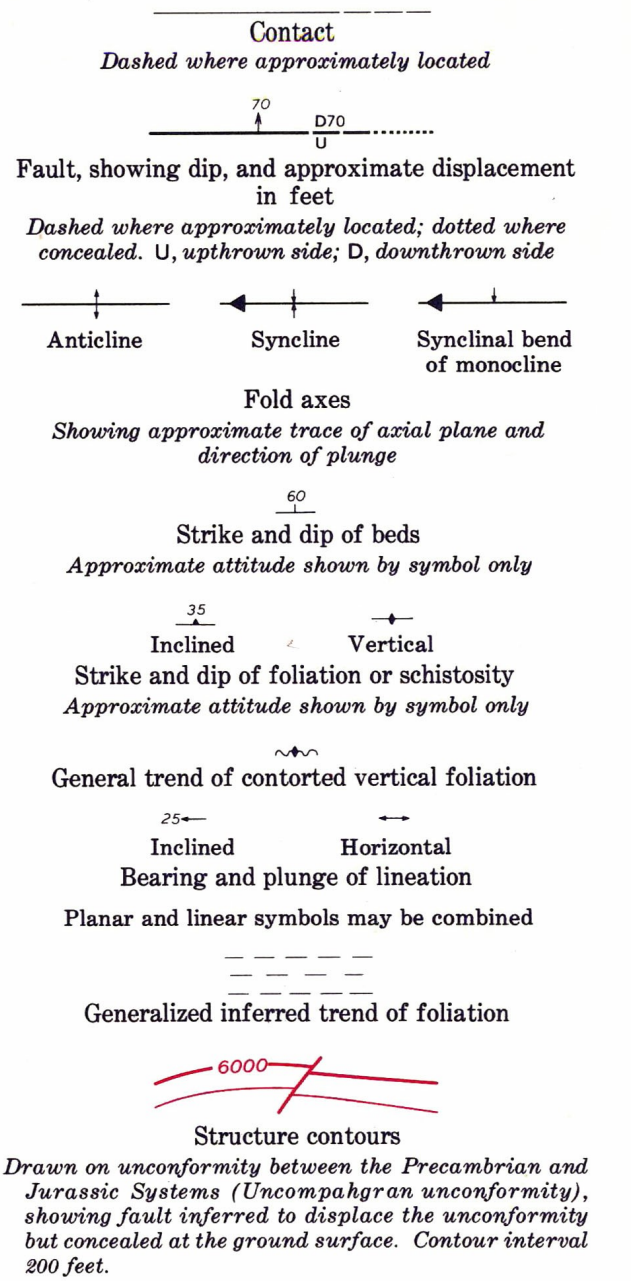
Stratigraphic Sections





Graphics from source map: Black Ridge Quadrangle

Map Legend



Graphic from source map: Black Ridge Quadrangle

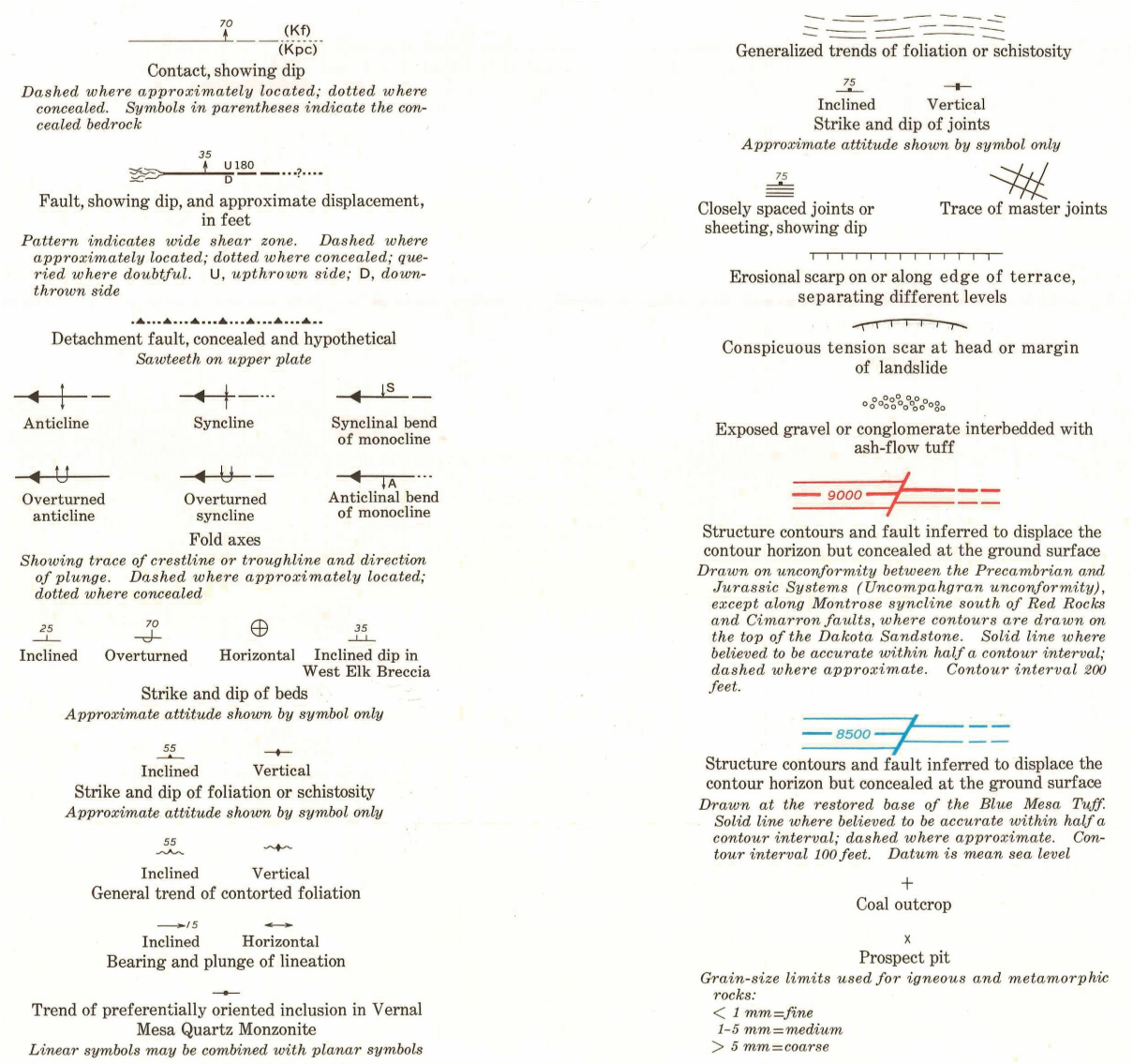
Black Canyon of the Gunnison River and Vicinity

The formal citation for this source.

Hansen, W.R., 1971, Geologic Map of the Black Canyon of the Gunnison River and Vicinity, Western Colorado: U.S. Geological Survey, Miscellaneous Geologic Investigations Map I-584, scale 1:24,000 (*GRI Source Map ID 8*).

Prominent graphics and text associated with this source are presented below.

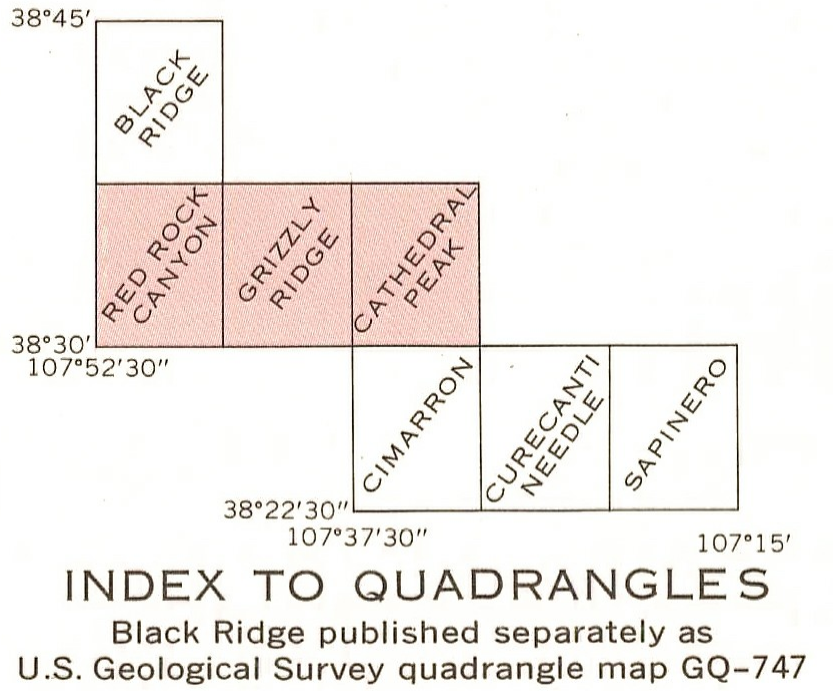
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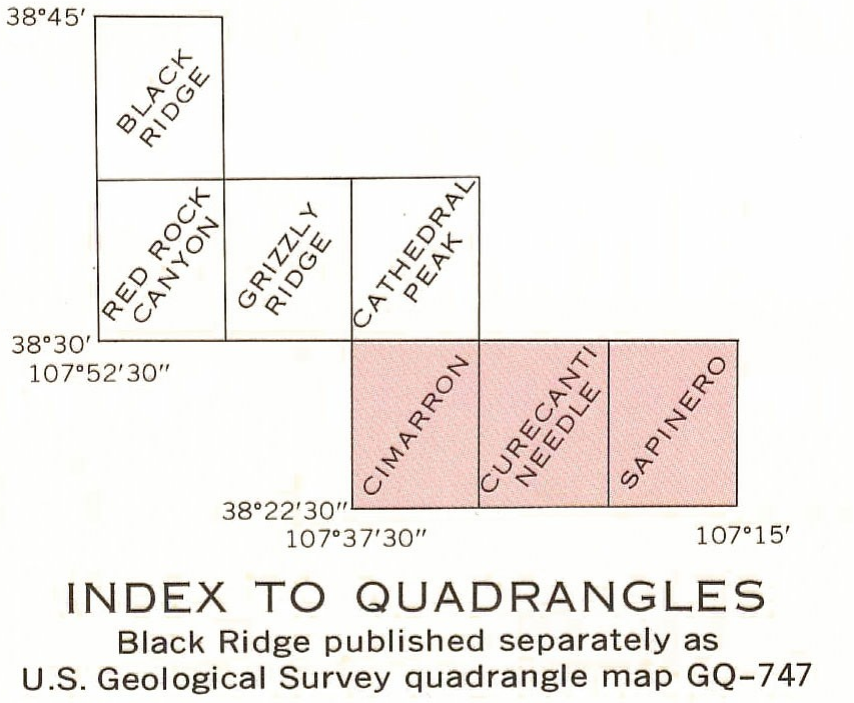
Graphic from source map: Black Canyon of the Gunnison River and Vicinity

Index to Quadrangles

I-584, Plate 1 Index to Quadrangles



I-584, Plate 2 Index to Quadrangles



Graphics from source map: Black Canyon of the Gunnison River and Vicinity

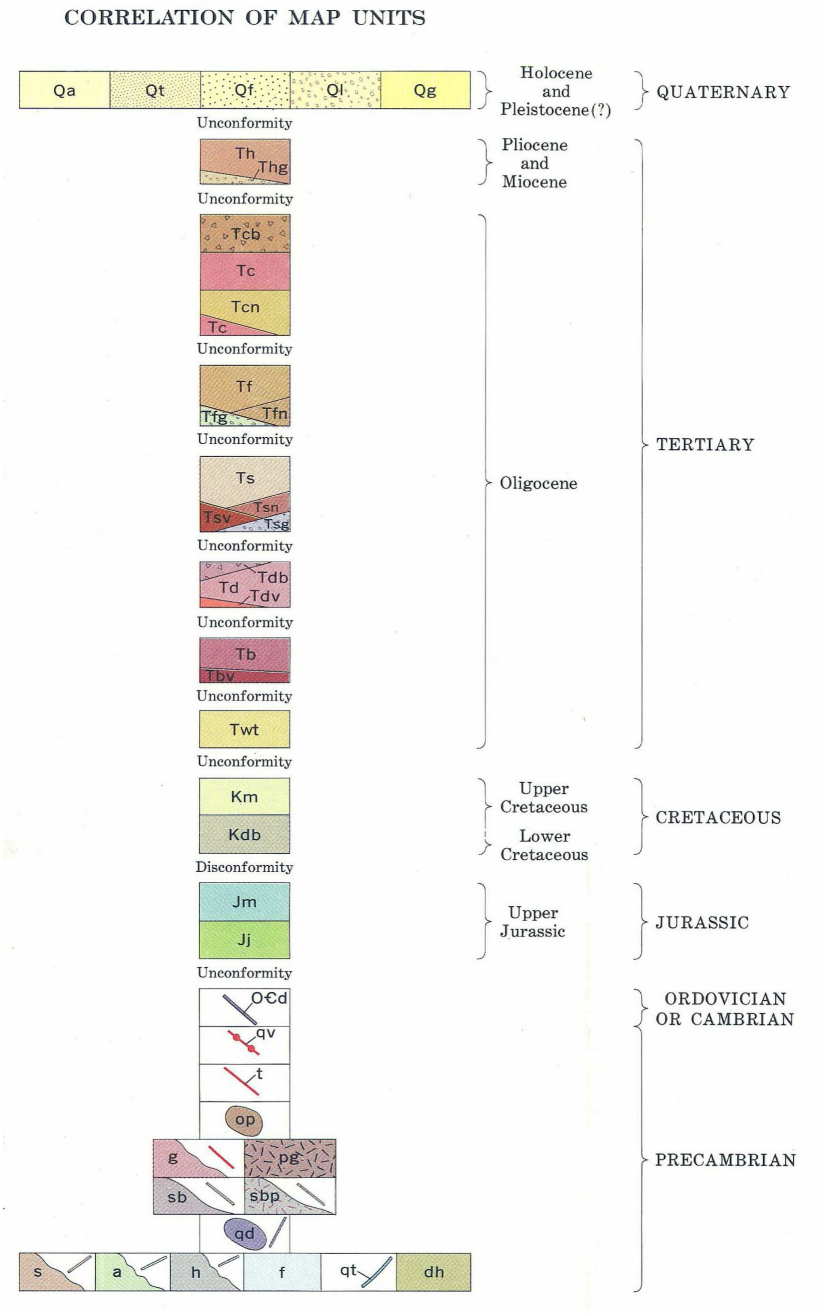
Big Mesa Quadrangle

The formal citation for this source.

Hedlund, D.C., 1974, Geologic Map of the Big Mesa Quadrangle, Gunnison County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1153, scale 1:24,000 (*GRI Source Map ID 26*).

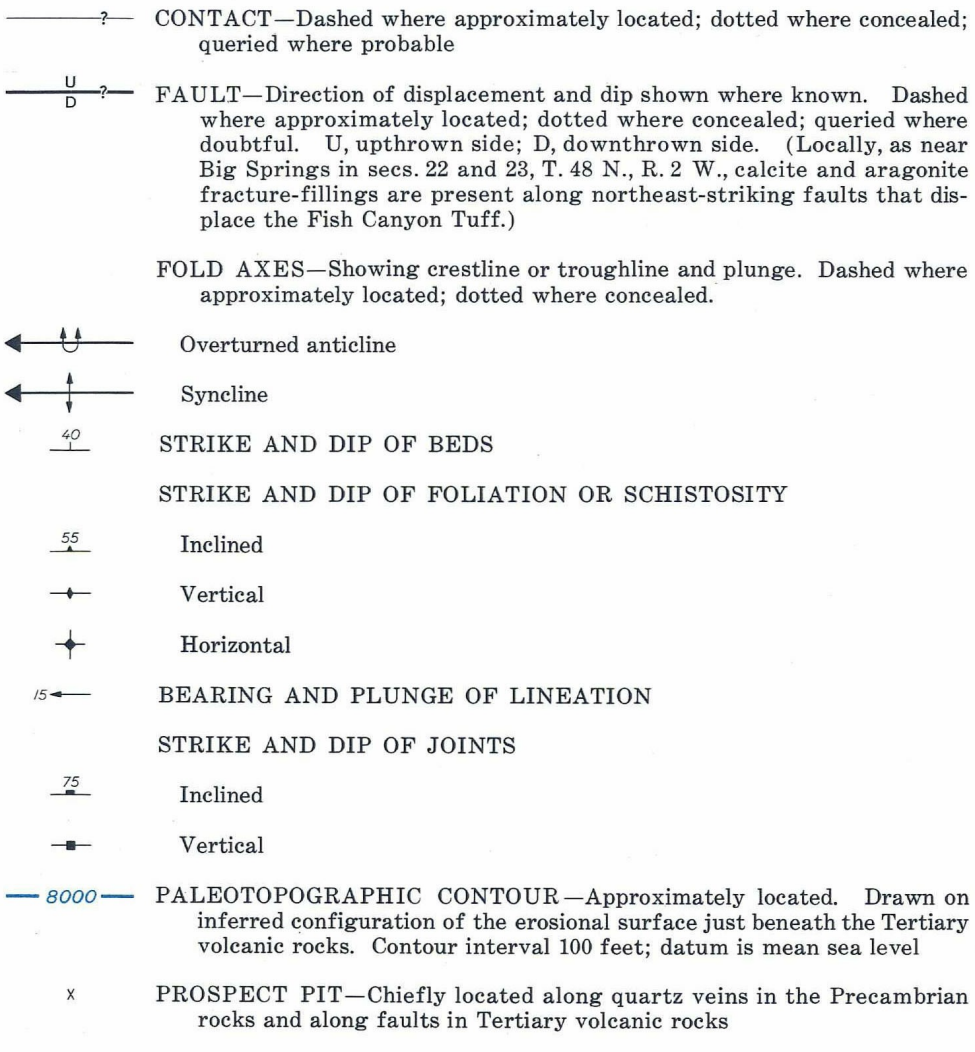
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Correlation of Map Units



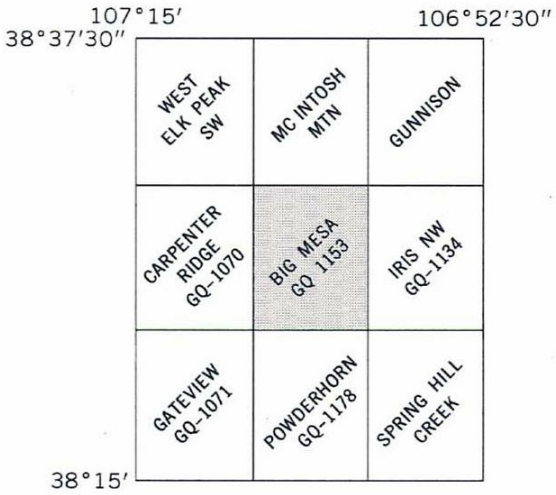
Graphic from source map: Big Mesa Quadrangle

Map Legend



Graphic from source map: Big Mesa Quadrangle

Index Map



INDEX SHOWING LOCATION OF BIG MESA QUADRANGLE (SHADED) AND OF PUBLISHED GEOLOGICAL QUADRANGLE (GQ) MAPS

(Big Mesa quadrangle was formerly named Iola quadrangle).

Graphic from source map: Big Mesa Quadrangle

References

Hansen, W.R., and Peterman, Z.E., 1968, Basement-rock geochronology of the Black Canyon of the Gunnison, Colorado: U.S. Geological Survey Professional Paper 600-C, p.C80-C90.

Hedlund, D.C., and Olson, J.C., 1974, Geologic map of the Carpenter Ridge quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1070.

Hedlund, D.C., and Olson, J.C.1974, Geologic map of the Iris NW quadrangle, Gunnison and Saguache Counties, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1134.

Hunter, J.F., 1925, Pre-Cambrian rocks of Gunnison River, Colorado: U.S. Geological Survey Bulletin 777, 94 p.

Larsen, E.S., Jr., and Cross, Whitman, 1956, Geology and petrology of the San Juan region, southwestern Colorado: U.S. Geological Survey Professional Paper 258, 303 p.

Olson, J.C., and Hedlund, D.C., 1973, Geologic map of the Gateview quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1071.

Olson, J.C., and Hedlund, D.C., and Hansen, W.R., 1968, Tertiary volcanic stratigraphy in the Powderhorn-Black Canyon region, Gunnison and Montrose Counties, Colorado: U.S. Geological Survey Bulletin 1251-C, p. C1-C29.

Ratte, J.C., and Steven, T.A., 1967, Ash flows and related volcanic rocks associated with the Creede caldera, San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 524-H, p. H1-H58.

Steven, T.A., and Ratte, J.C., 1964, Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 475-D, p. D54-D63.

Text from source map: Big Mesa Quadrangle

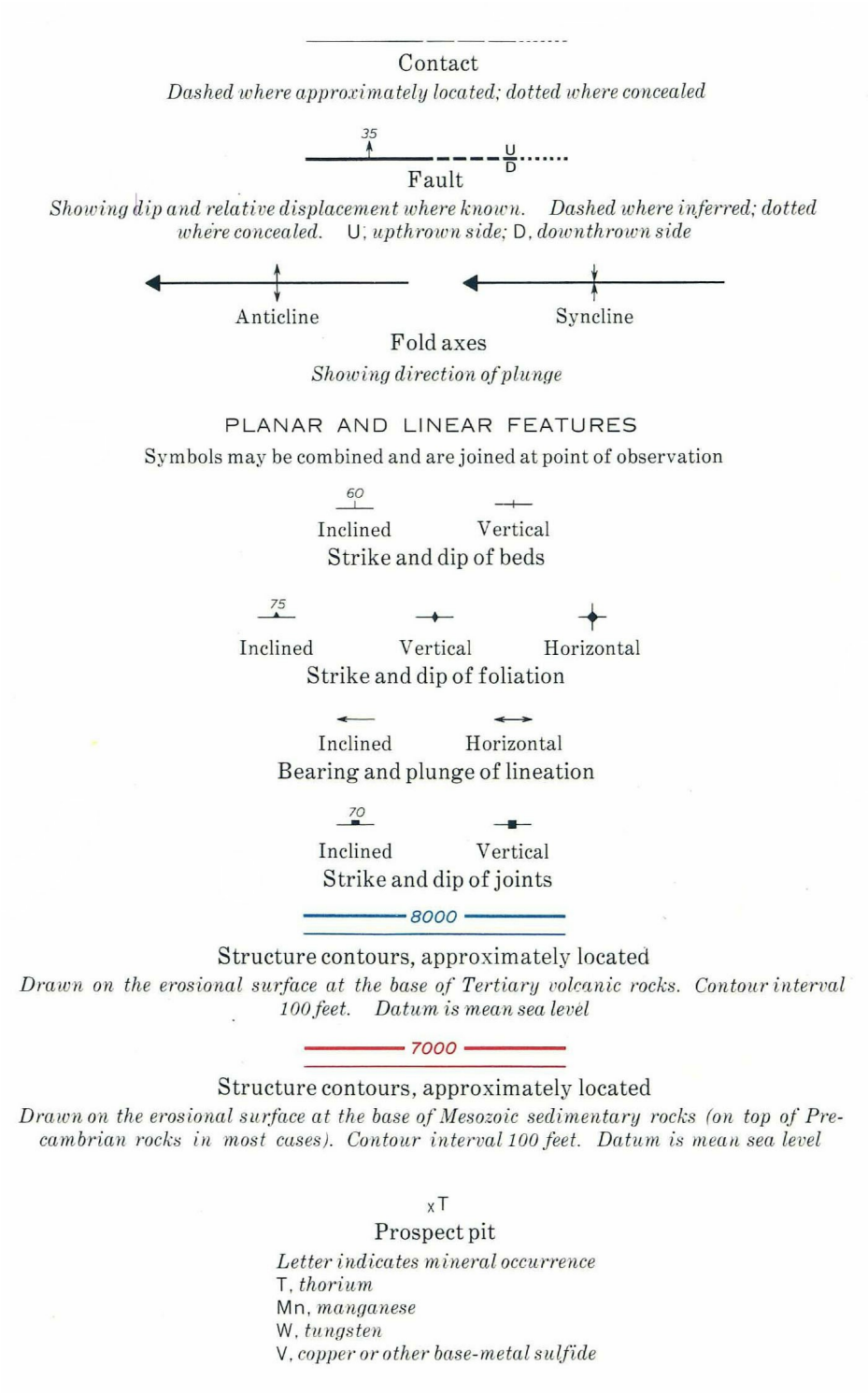
Carpenter Ridge Quadrangle

The formal citation for this source.

Hedlund, D.C., and Olson, J.C., 1973, Geologic Map of the Carpenter Ridge Quadrangle, Gunnison County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1070, scale 1:24,000 (*GRI Source Map ID 27*).

Prominent graphics and text associated with this source are presented below.

Map Legend



Graphic from source map: Carpenter Ridge Quadrangle

Selected Bibliography

Atwood, W.W., and Mather, K.F., 1932, Physiography and Quaternary geology of the San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 166, 176 p.
Hansen, W.R., 1965, The Black Canyon of the Gunnison, today and yesterday: U.S. Geological Survey Bulletin 1191, 76 p.
Hansen, W.R., 1971, Geologic map of the Black Canyon of the Gunnison River and vicinity, western Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-584.
Hansen, W.R., and Peterman, Z.E., 1968, Basement-rock geochronology of the Black Canyon of the Gunnison, Colorado: U.S. Geological Survey Professional Paper 600-C, p. C80-C90.
Hunter, J.F., 1925, Pre-Cambrian rocks of Gunnison River, Colorado: U.S. Geological Survey Bulletin 777, 94 p.
Larsen, E.S., Jr., and Cross, Whitman, 1956, Geology and petrology of the San Juan region, southwestern Colorado: U.S. Geological Survey Professional Paper 258, 303 p.
Lipman, P.W., Steven, T.A., and Mehnert, H.H., 1970, Volcanic history of the San Juan Mountains, CO, as indicated by potassium-argon dating: Geological Society of America Bulletin, v. 81, p. 2329-2352.
Olson, J.C., Hedlund, D.C., and Hansen, W.R., 1968, Tertiary volcanic stratigraphy in the Powderhorn-Black Canyon Region, Gunnison and Montrose Counties, Colorado: U.S. Geological Survey Bulletin 1251-C.
Olson, J.C., and Wallace, S.R., 1956, Thorium and rare-earth minerals in Powderhorn district, Gunnison County, Colorado: U.S. Geological Survey Bulletin 1027-0, p. 693-723.

Text from source map: Carpenter Ridge Quadrangle

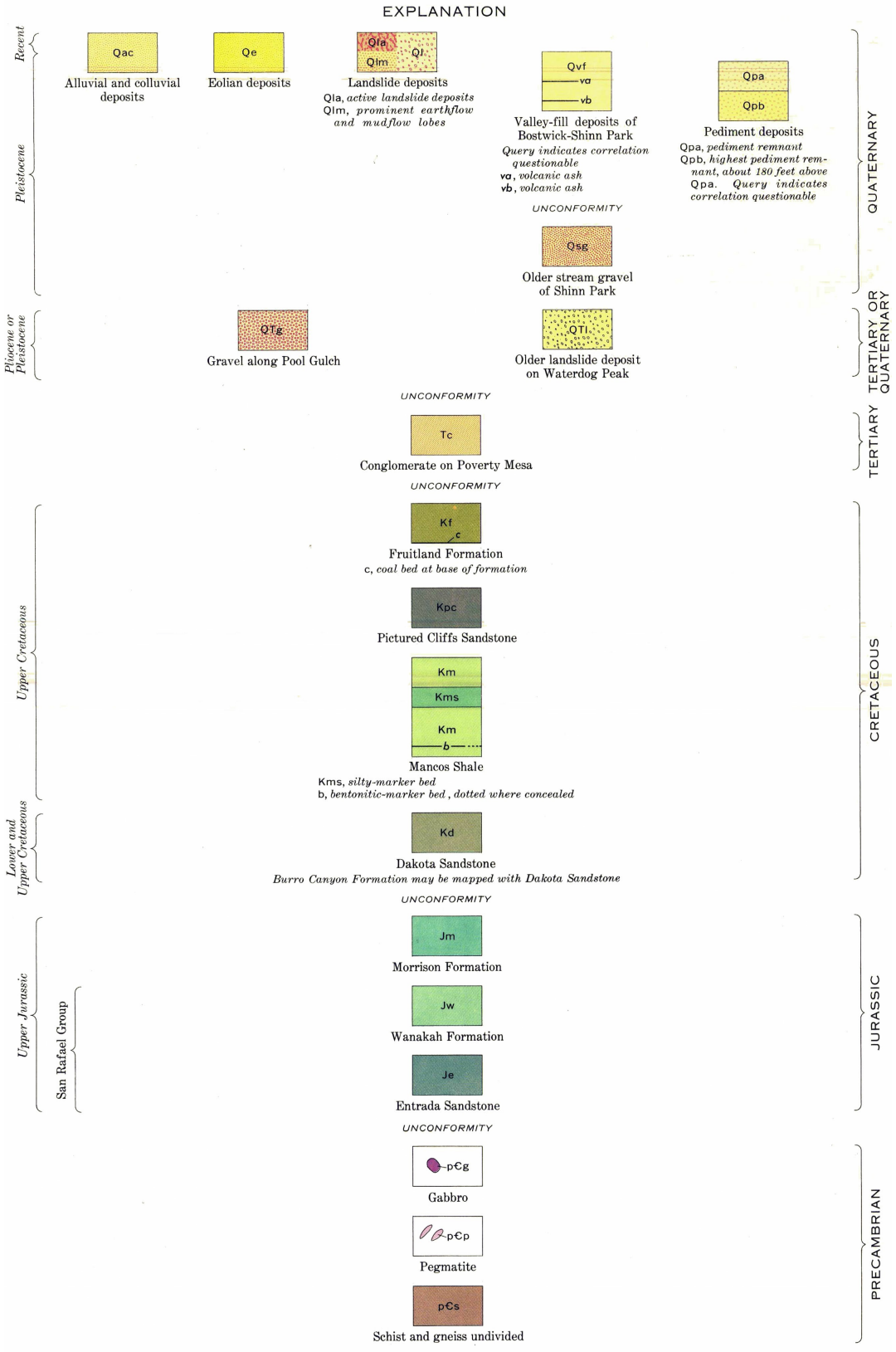
Cerro Summit Quadrangle

The formal citation for this source.

Dickinson, R.G., 1965, Geologic Map of the Cerro Summit Quadrangle, Montrose County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-486, scale 1:24,000 (*GRI Source Map ID 3*).

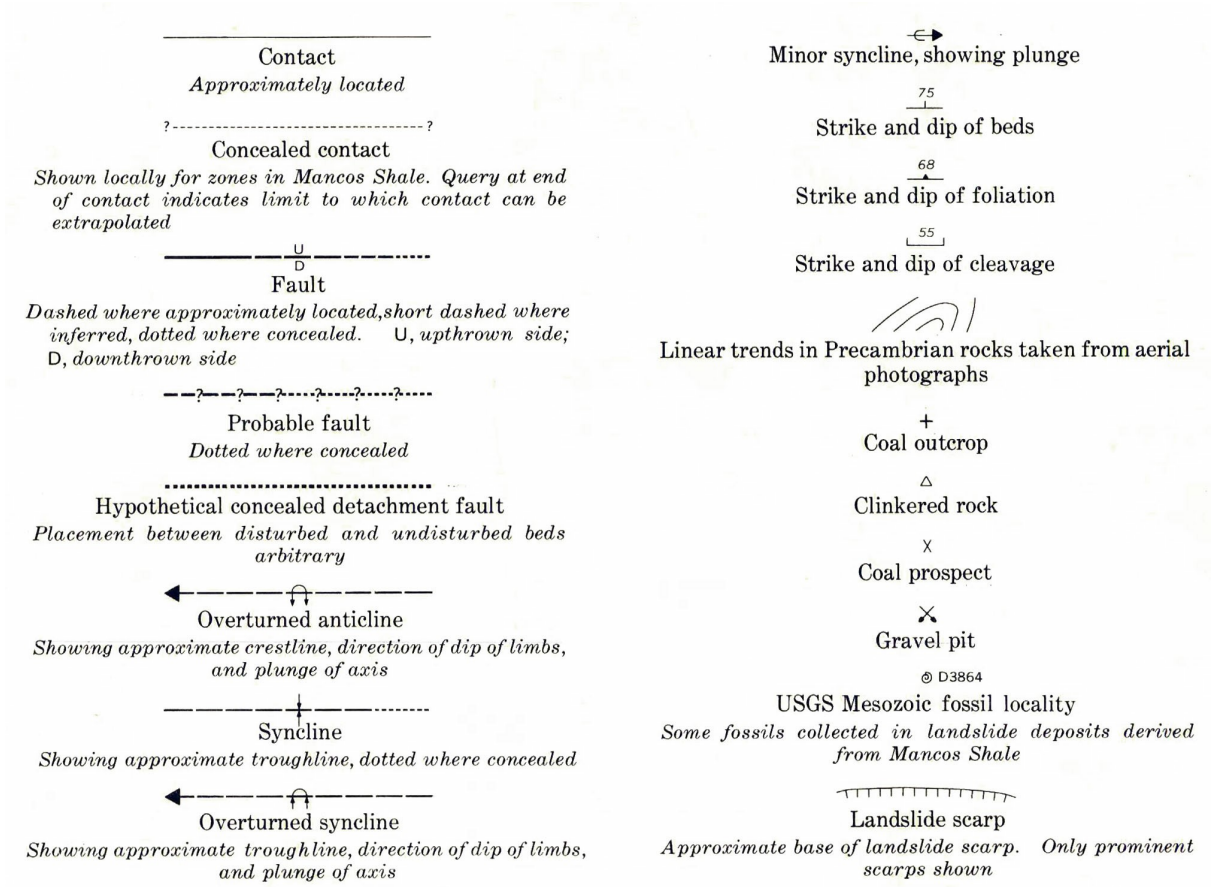
Prominent graphics and text associated with this source are presented below.

Correlation of Map Units



Graphic from source map: Cerro Summit Quadrangle

Map Legend



Graphic from source map: Cerro Summit Quadrangle

Table 1. Faunal Zones

Upper Cretaceous stages	Reference sequence Durango, Colo. area	Upper Cretaceous faunal zones (W. A. Cobban, written communication, 1964)	USGS Mes. fossil locs. (x denotes zone collected in adjacent area)
Maestrichtian	Upper part of Animas Formation	*Triceratops*	
	McDermott Member of Animas Formation	*Discoscaphites nebrascensis*	
		Discoscaphites nicolletii	
	Kirtland Shale	*Sphenodiscus* cf. *lenticularis*	
		Baculites clinolobatus	
	Fruitland Formation	*Baculites grandis*	
		Baculites baculus	
?	Pictured Cliffs Sandstone	*Baculites eliasi*	
Campanian		*Baculites jenseni*	
		Baculites reesidei	
		Baculites cuneatus	
		Baculites compressus	
	Lewis Shale	*Didymoceras cheyennense*	x
		Exiteloceras jenneyi	D3178, D4310
		Didymoceras stevensoni	D3856?
		Didymoceras nebrascense	D3177?, D3859
		Baculites scotti	x
		Baculites gregoryensis	
		Baculites perplexus	D3851, D3852, D3853, D3862, D3863, D3864, D3865, D3867, D3869, D3873
		Baculites smooth species	
		Baculites asperiformis	D3846, D3847, D3849, D4309
	Mesaverde Group (type area)	*Baculites mclearni*	
		Baculites obtusus	
		Scaphites hippocrepis	
Santonian	Mancos Shale	*Desmoscaphites bassleri*	
		Desmoscaphites erdmanni	
		Clioscaphites choteauensis	
		Clioscaphites vermiformis	
Coniacian		*Scaphites depressus*	D3844?
		Scaphites ventricosus	
?		*Inoceramus deformis*	
Turonian		*Scaphites corvensis*	
		Scaphites nigricollensis	
		Scaphites whitfieldi	
		Scaphites warreni	x
		Prionocyclus hyatti	
		Selwynoceras woollgari	
		Inoceramus labiatus	
		Sciponoceras gracile	
Cenomanian		*Dunveganoceras albertense*	
		Dunveganoceras conditum	
		Dunveganoceras pondi	
		Plesiacanthoceras wyomingense	
		Plesiacanthoceras amphibolum	
	Dakota Sandstone	*Calycoceras* sp.	

Mancos Shale of Cerro Summit quadrangle

TABLE 1. FAUNAL ZONES REPRESENTED BY USGS MESOZOIC FOSSIL LOCALITIES IN THE CERRO SUMMIT QUADRANGLE
FAUNAL ZONES NOT DETERMINED FOR ALL LOCALITIES ON THE MAP

Graphic from source map: Cerro Summit Quadrangle

Gateview Quadrangle

The formal citation for this source.

Olson, J.C., and Hedlund, D.C., 1973, Geologic Map of the Gateview Quadrangle, Gunnison County, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1071, scale 1:24,000 (*GRI Source Map ID 28*).

Prominent graphics and text associated with this source are presented below.

Map Legend



Contact, showing dip

Dashed where approximately located; dotted where concealed



Fault, showing dip

Dashed where inferred; dotted where concealed. U, *upthrown side;* D, *downthrown side*

PLANAR AND LINEAR FEATURES

Symbols may be combined and are joined at point of observation



Inclined



Vertical

Strike and dip of beds



Inclined



Vertical

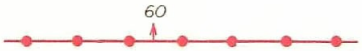
Strike and dip of foliation

Bearing and plunge of lineation



Structure contours, approximately located

Drawn on the erosional surface at the base of Tertiary volcanic rocks. Contour interval 100 feet.



Vein, predominantly quartz, showing dip



Prospect pit



Adit

Letter indicates mineral occurrence

T, *thorium*
Mn, *manganese*
V, *copper or other base-metal sulfide*

Graphic from source map: Gateview Quadrangle

Selected Bibliography

Atwood, W.W., and Mather, K.F., 1932, Physiography and Quaternary geology of the San Juan Mountains, CO: U.S. Geological Survey Professional Paper 166, 176 p.
Hansen, W.R., 1971, Geologic map of the Black Canyon of the Gunnison River and vicinity, western CO: U.S. Geological Survey Miscellaneous Investigations Map I-584.
Hansen, W.R., and Peterman, Z.E., 1968, Basement-rock geochronology of the Black Canyon of the Gunnison, CO: U.S. Geological Survey Professional Paper 600-C, p. C80-C90.
Hedlund, D.C., and Olson, J.C., 1961, Four environments of thorium-, miobium, and rare-earth-bearing minerals in the Powderhorn district of southwestern Colorado: U.S. Geological Survey Professional Paper 424-B, p. B283-B286.
Hunter, J.F., 1925, Pre-Cambrian rocks of Gunnison River, Colorado: U.S. Geological Survey Bulletin 777, 94 p.
Larsen, E.S., Jr., and Cross, Whitman, 1956, Geology and petrology of the San Juan region, southwestern Colorado: U.S. Geological Survey Professional Paper 258, 303 p.
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Olson, J.C., and Wallace, S.R., 1956, Thorium and rare-earth minerals in Powderhorn district, Gunnison County, Colorado: U.S. Geological Survey Bulletin 1027-0, p. 693-723.

Text from source map: Gateview Quadrangle

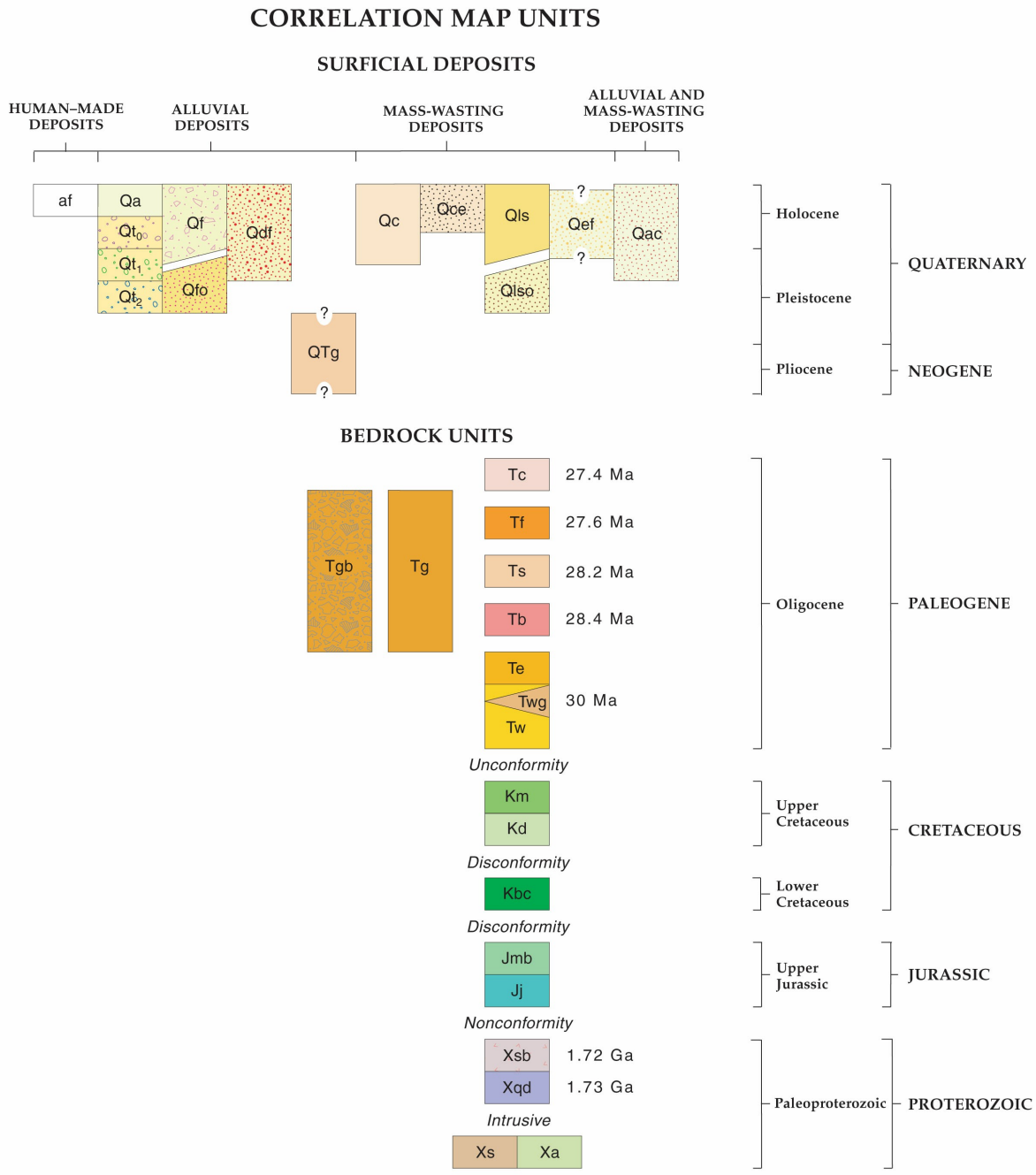
Gunnison Quadrangle

The formal citation for this source.

Stork, Allen, Coogan, James C., Csar, Alex, and Wentz, Raelene, 2006, Geologic Map of the Gunnison Quadrangle, Gunnison County, Colorado: Colorado Geological Survey, Open-File Report OF-06-04, scale 1:24,000 (*GRI Source Map ID 76271*).

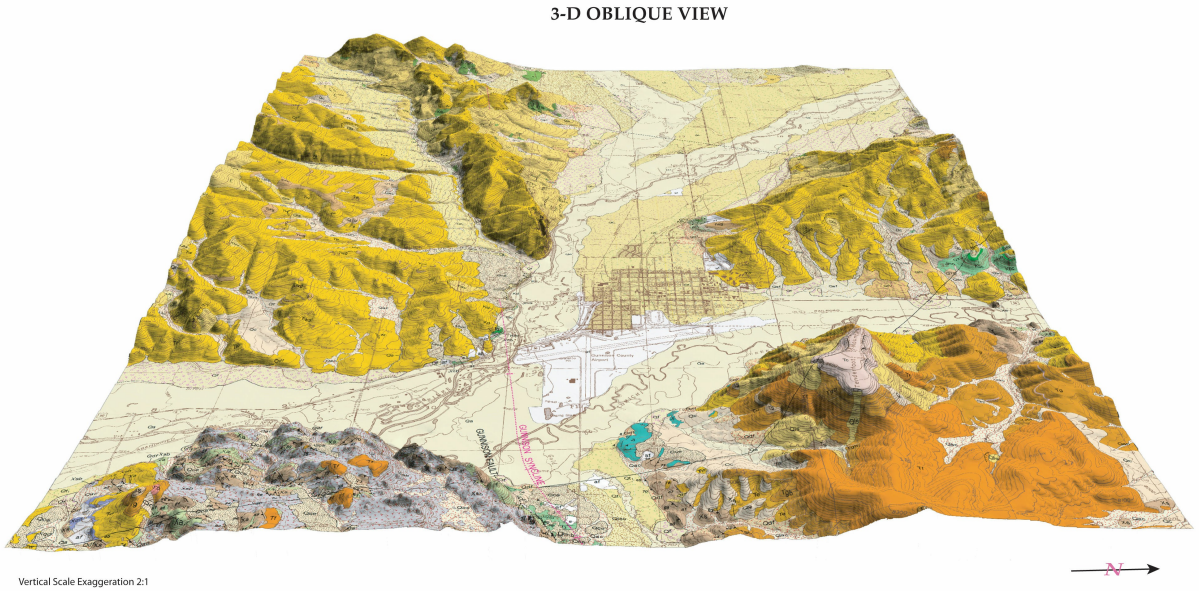
Prominent graphics and text associated with this source are presented below.

Correlation of Map Units



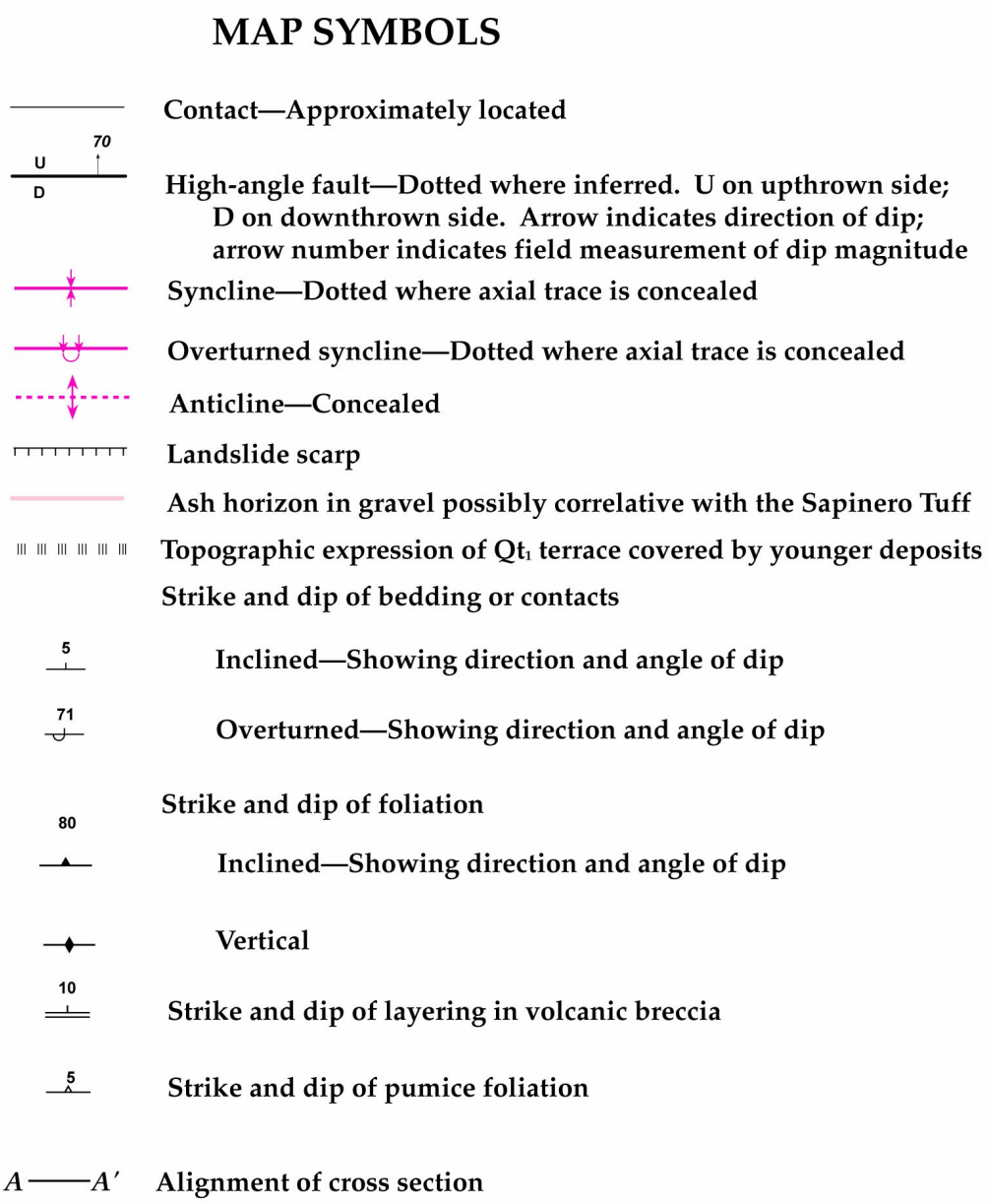
Graphic from source map: Gunnison Quadrangle

3-D Oblique View



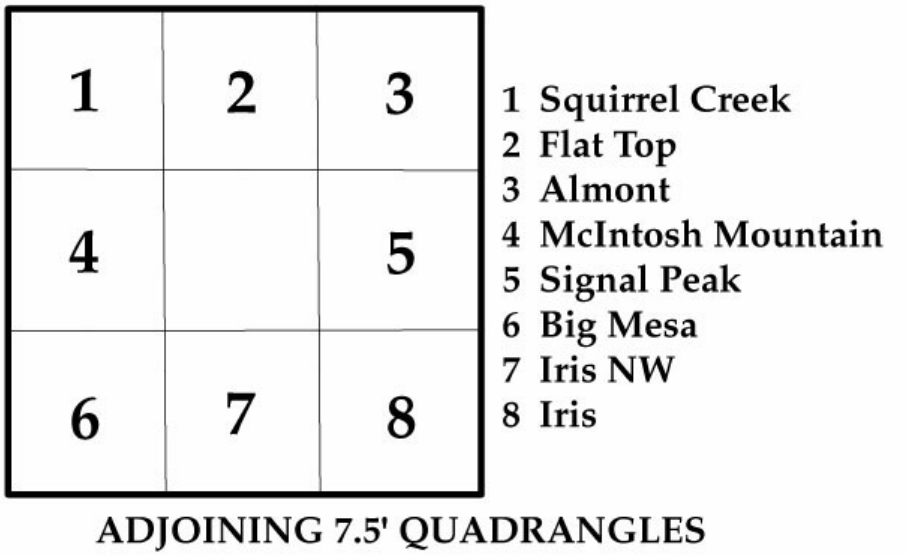
Graphic from source map: Gunnison Quadrangle. x2 vertical exaggeration indicated on source map.

Map Symbols



Graphic from source map: Gunnison Quadrangle

Adjoining 7.5' Quadrangles



Graphic from source map: Gunnison Quadrangle

Author's Notes

The author's notes document for the Gunnison Quadrangle source map (Open-File Report OF-06-04) is embedded as a PDF document. To access the document double-click the following link: OF-06-04 Gunnison Authors Notes.pdf. The Table of Contents and List of Figures for the Author's Notes document is presented below.

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ACKNOWLEDGEMENTS 3
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Text from source map: Gunnison Quadrangle. Note that unit descriptions for this source map are provided within this document (blca-cure_geology.pdf) in the Map Unit Descriptions section.

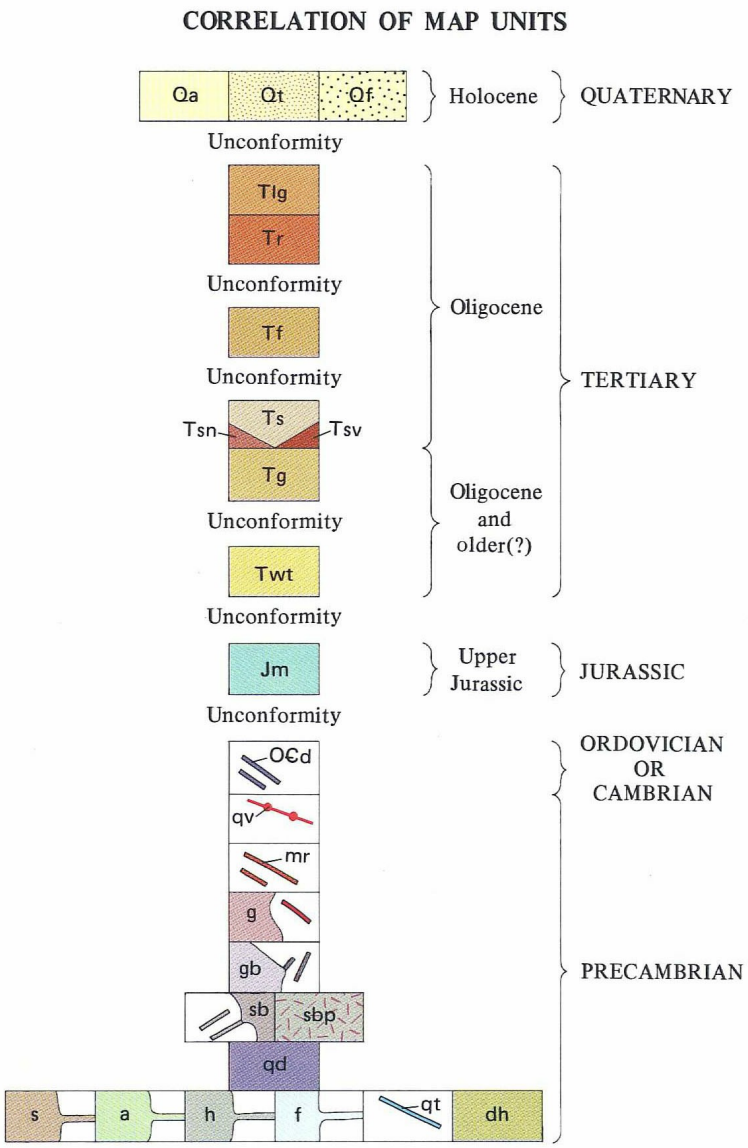
Iris NW Quadrangle

The formal citation for this source.

Hedlund, D.C., and Olson, J.C., 1973, Geologic Map of the Iris NW Quadrangle, Gunnison and Saguache Counties, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1134, scale 1:24,000 (*GRI Source Map ID 29*).

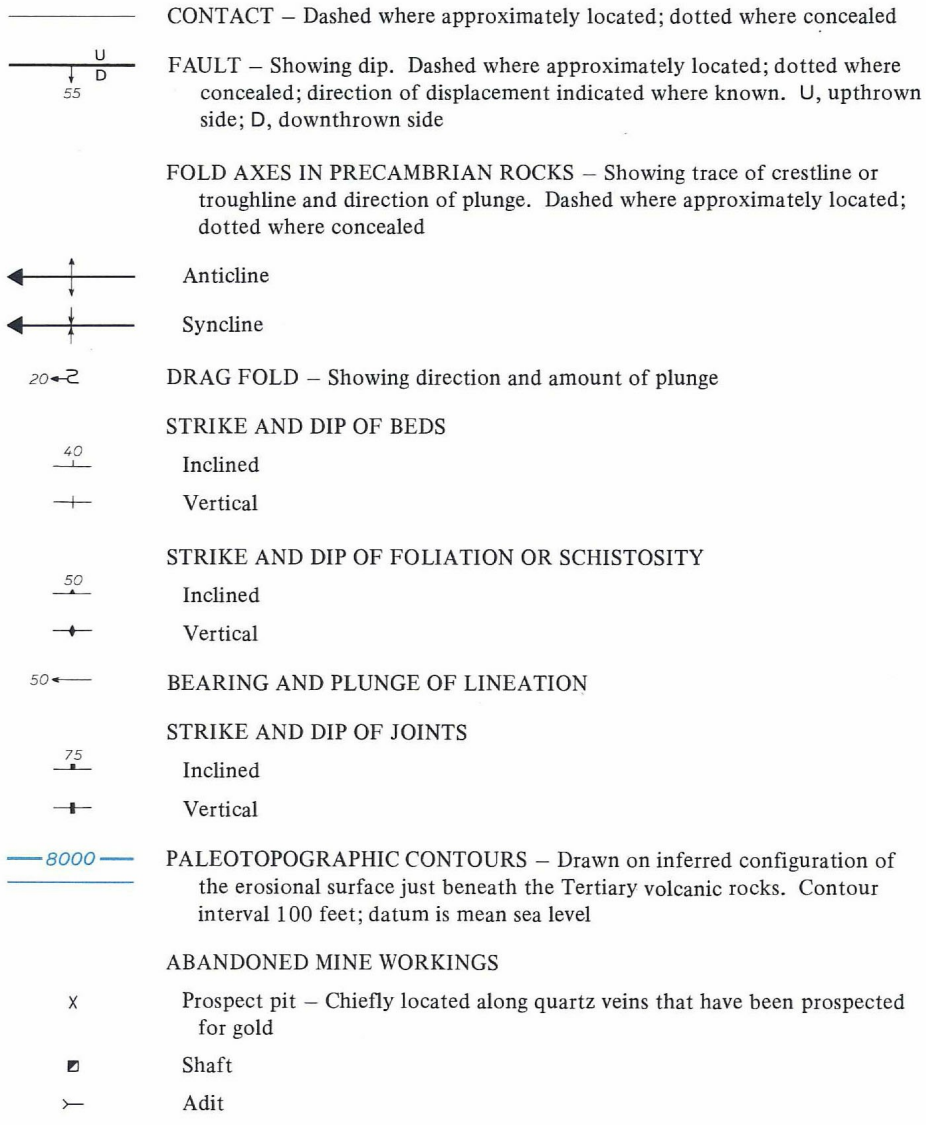
Prominent graphics and text associated with this source are presented below.

Correlation of Map Units



Graphic from source map: Iris NW Quadrangle

Map Legend



Graphic from source map: Iris NW Quadrangle

References

Hansen, W.R. and Peterman, Z.E., 1968, Basement-rock geochronology of the Black Canyon of the Gunnison, CO: U.S. Geological Survey Professional Paper 600-C, p.C80-C90.

Hedlund, D.C., and Olson, J.C., 1973, Geologic map of the Carpenter Ridge quadrangle, CO: U.S. Geological Survey Geologic Quadrangle Map GQ-1070.

Hunter, J.F., 1925, Pre-Cambrian rocks of Gunnison River, CO: U.S. Geological Survey Bulletin 777, 94 p.

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Olson, J.C., and Hedlund, D.C., and Hansen, W.R., 1968, Tertiary volcanic stratigraphy in the Powderhorn-Black Canyon region, Gunnison and Montrose Counties, Colorado: U.S. Geological Survey Bulletin 1251-C, 29 p.
Ratte, J.C., and Steven, T.A., 1967, Ash flows and related volcanic rocks associated with the Creede caldera, San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 524-H, 58 p.
Steven, T.A., and Ratte, J.C., 1964, Revised Tertiary volcanic sequence in the central San Juan Mountains, CO, in Short papers in geology and hydrology: U.S. Geological Survey Professional Paper 475-D, p. D54-D63.
Steven, T.A., and Ratte, J.C.1973, Geologic map of the Creede quadrangle, Mineral and Saguache Counties, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1053.

Text from source map: Iris NW Quadrangle

Little Soap Park Quadrangle

The formal citation for this source.

Gaskill, D., Stork, A., Fillmore, R., and Coven, B., 1999, Geologic Map of the Little Soap Park Quadrangle: Western State College of Colorado, unpublished map, scale 1:24,000 (*GRI Source Map ID 934*).

Prominent text associated with this source is presented below.

Map Notes

Unit descriptions for the McIntosh Mountain and Little Soap Park Quadrangles are from our fieldwork (July-September 1999) and published descriptions by Olson et al. (1968), Hansen, Hedlund and Olson (1973), Hedland (1974), and Gaskill et al. (1981). We have attempted to maintain unit consistency with the previous studies but have some recommendations for changes in unit nomenclature that will facilitate more accurate mapping of time-correlative units in the Curecanti National Recreation Area and the adjacent areas of the West Elk and San Juan Mountains.

In particular the gravel stratigraphy of this region is more complicated than previously mapped. There are two distinct types of gravels:

1) there are Tertiary volcanic gravels that were shed continuously of the slopes of West Elk Volcano and;

2) there are gravels that contain clasts of older non-volcanic rocks that are presumed to record deposition in through-going streams that drained the Sawatch uplift to the east and record positions of the paleo-Gunnison River.

Both types of gravels are found at different stratigraphic horizons, an indication of the continuous activity of these streams. We have found volcanic gravels between the Sapinero and Fish Canyon Tuffs (Tfvg), between the Fish Canyon and Carpenter Ridge Tuffs (Tcvg), and there are extensive deposits that cap all of these units and the West Elk Breccia (Tmvg). The first two correlate with gravels mapped by Hedulund (1974) and the last one is recognized for the first time in this study. Hansen (1971) mapped similar units as small circles between the below Dillon Mesa Tuff (should be Tdvg) and below the Sapinero Mesa Tuff (Tsvg). We have found non-volcanic gravels below the Tuff of East Elk Creek (Tepg), below the Blue Mesa Tuff (Tbpg), below the Sapinero Mesa Tuff (Tspg),

below the Fish Canyon Tuff (Tfpg), and between the Carpenter Ridge Tuff and the highest volcanic gravel (Tmpg).

We have also discovered significant discrepancies in the nomenclature for members of the West Elk Breccia between the work of Hansen (1971) and Hedlund and Olson (1973) that we have addressed in our map unit descriptions.

Text from source map: Little Soap Park Quadrangle

McIntosh Mountain Quadrangle

The formal citation for this source.

Stork, A., Panter, K., Murphy, R., and Stooksbury, B., 1999, Geologic Map of the McIntosh Mountain Quadrangle: Western State College of Colorado, unpublished map, scale 1:24,000 (*GRI Source Map ID 935*).

Prominent text associated with this source is presented below.

Map Notes

Unit descriptions for the McIntosh Mountain and Little Soap Park Quadrangles are from our fieldwork (July-September 1999) and published descriptions by Olson et al. (1968), Hansen, Hedlund and Olson (1973), Hedland (1974), and Gaskill et al. (1981). We have attempted to maintain unit consistency with the previous studies but have some recommendations for changes in unit nomenclature that will facilitate more accurate mapping of time-correlative units in the Curecanti National Recreation Area and the adjacent areas of the West Elk and San Juan Mountains.

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Text from source map: McIntosh Mountain Quadrangle

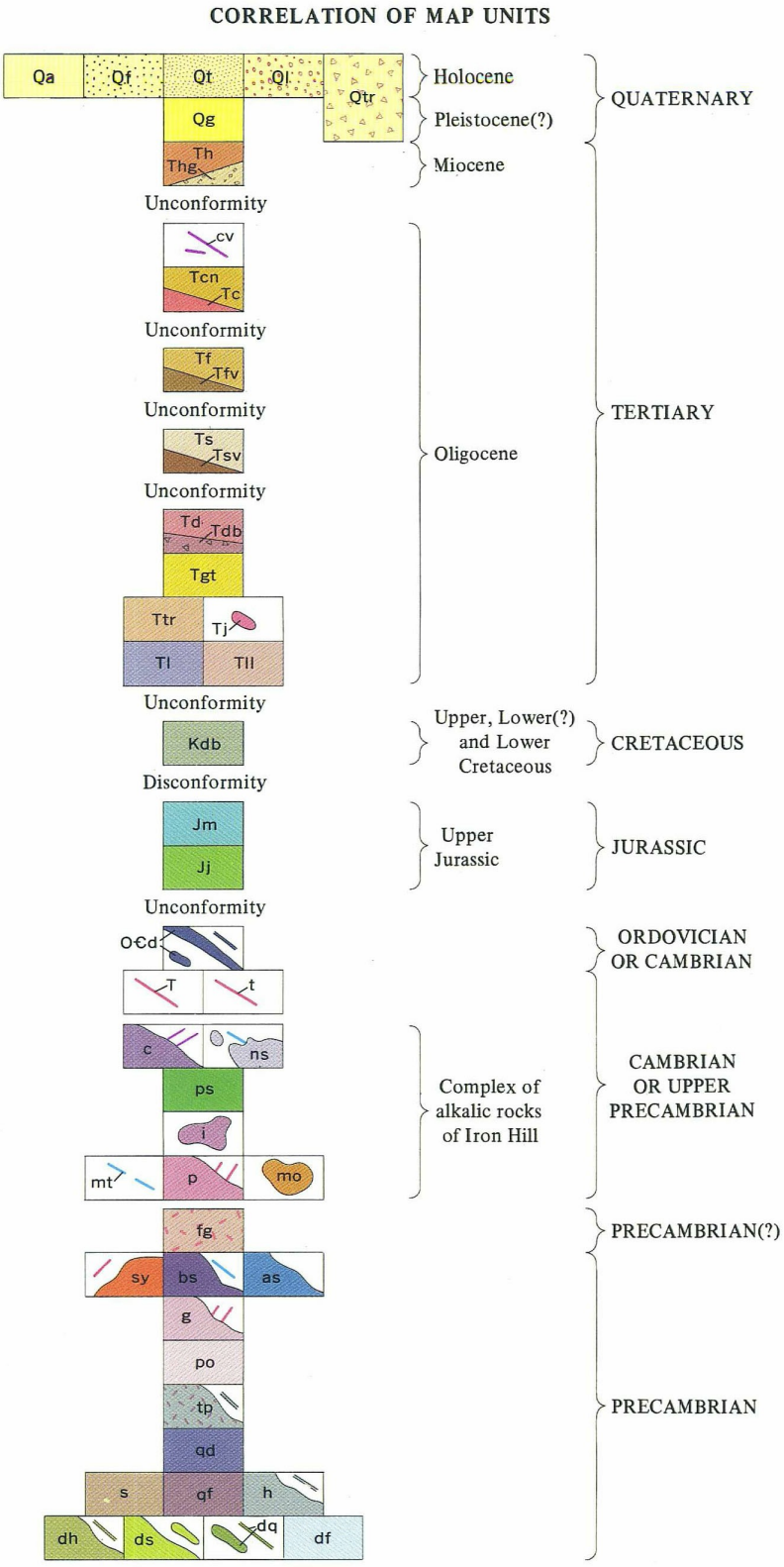
Powderhorn Quadrangle

The formal citation for this source.

Hedlund, D.C., and Olson, J.C., 1975, Geologic Map of the Powderhorn Quadrangle, Gunnison and Saguache Counties, Colorado: U.S. Geological Survey, Geological Quadrangle Map GQ-1178, scale 1:24,000 (*GRI Source Map ID 30*).

Prominent graphics and text associated with this source are presented below.

Correlation of Map Units



Graphic from source map: Powderhorn Quadrangle

Map Legend

AREA OF ROCKS ALTERED TO FENITE – Gray, medium-grained syenitic rock (fenite) formed by alkali metasomatism of Precambrian granites and felsite; composed chiefly of microcline with lenticular aggregates of aegirine-augite; perthitic microcline contains abundant string-and-patch varieties of albite intergrowth; aegirine-augite replaces biotite in the original granite; contacts with Precambrian country rocks generally gradational. Fenitization occurred in Cambrian or late Precambrian time as the initial phase of intrusion of the complex of alkalic rocks of Iron Hill

CONTACT – Dashed where approximately located; dotted where concealed

FAULT – Showing dip. Dashed where approximately located; dotted where concealed; queried where probable; direction of displacement indicated where known. U, upthrown side; D, downthrown side

VEIN – Showing dip. qv, quartz vein, where identified

STRIKE AND DIP OF BEDS

STRIKE AND DIP OF FLOW LAYERING IN TERTIARY LAVA FLOWS

Inclined

Vertical

STRIKE AND DIP OF FOLIATION OR SCHISTOSITY

Inclined

Vertical

BEARING AND PLUNGE OF LINEATION – May be combined with planar symbols

STRIKE AND DIP OF JOINTS IN TERTIARY VOLCANIC ROCKS

Inclined

Vertical

STRIKE AND DIP OF JOINTS IN PRECAMBRIAN ROCKS

Inclined

Vertical

PALEOTOPOGRAPHIC CONTOURS – Approximately located. Drawn on inferred configuration of the erosional surface just beneath the Tertiary volcanic rocks. Contour interval 100 feet; datum is mean sea level

ABANDONED MINE WORKINGS – Letter symbol indicates mineral occurrence where known: T, thorium; Mn, manganese; V, gold, silver, or copper or other base-metal sulfide; Te, tellurium. Numerous prospect pits in pyroxenite are in vermiculite pods

Prospect pit

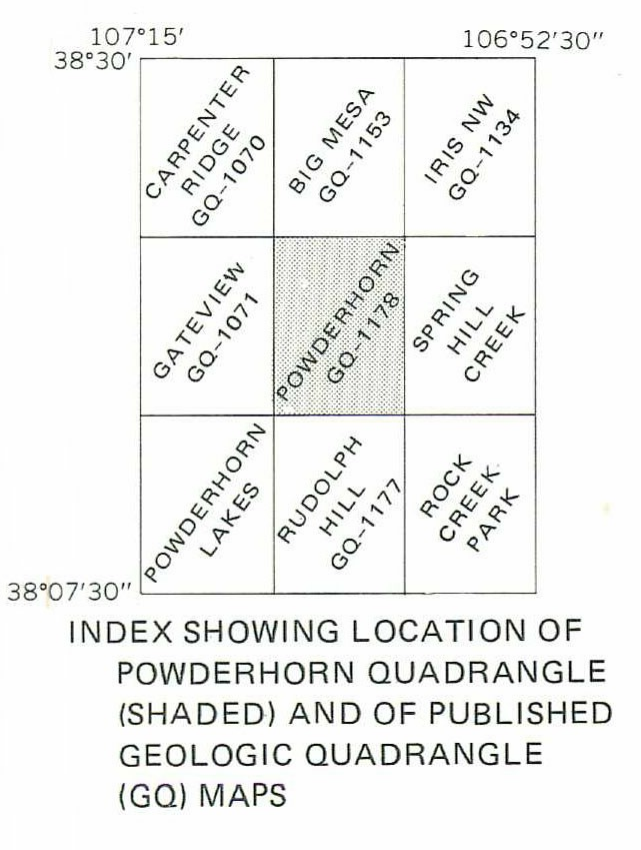
Shaft

Adit

Caved adit

Graphic from source map: Powderhorn Quadrangle

Index Map



Graphic from source map: Powderhorn Quadrangle

Economic Geology

Mineral vein occurrences are indicated by letter symbols: T, thorium; Mn, manganese; V, gold, silver, or copper or other base-metal sulfide; and Te, tellurium. Low-grade niobium, titanium, and vermiculite deposits are associated with the carbonatite and pyroxene of the Iron Hill stock.

At least 98 thorium-bearing veins and about 40 trachyte dikes have been examined which have radioactivities 2-250 times background. The veins are commonly along shear and breccia zones within Precambrian rocks, preferentially strike N. 50°-80° E., and have nearly vertical dips. The wallrocks of many veins have been partly replaced by pink to red orthoclase. At the Little Johnnie mine, an anastomosing vein system is as much as 5 feet wide and 3,500 feet long. (Olson and Wallace, 1956). The thoria content of high-grade samples from the Little Johnnie mine is as much as 4 percent, but in this and most other veins in the district the thoria content is generally a few tenths percent or less. The thorium vein system in secs. 16 and 20 west of the Old Lot mine follows a N. 50° E.-striking fault for about 8,000 feet. At the Whitney prospect a trachyte dike with radioactivity as much as 250 times background contains iron-oxide and thorogummite (?) pseudomorphs after altered and disseminated pyrite. The thorite veins typically contain thorite and thorogummite (?), or orthoclase, smoky quartz, barite, specular hematite, earthy hematite, goethite, calcite, fluorite, sodic

amphibole, biotite, apatite, pyrite, chalcopyrite, galena, and sphlerite. Rare earths and niobium are commonly present in anomalous amounts in the thorium-bearing veins.

Veins containing gold, silver, copper, and locally telluride minerals occur chiefly in the Dubois Greenstone in a zone across the northern part of the quadrangle termed the Gunnison gold belt. The production from the veins of the quadrangle probably amounts to several hundred thousand dollars, chiefly from the Good Hope-Vulcan mines, near the northeast edge of the quadrangle, which were worked in 1898-1904 and in several other short periods. The vein strikes N. 87° W., dips 85°N., averages about 3 feet in thickness, and extends, nearly parallel to the schistosity of the enclosing quartz-sericite schist, from the Vulcan claim westward through the Mammoth Chimney claim to the Good Hope claim. The vein replaces the schist, and the seams of ore merge into the schist without sharp contacts. Lenticular high-grade quartz masses, commonly 12-14 inches thick, occur along the hanging wall of a lower grade pyritic zone 2-30 feet thick. The ore mineral assemblage includes pyrite, chalcopyrite, sphalerite, vulcanite (CuTe) (Cameron and Threadgold, 1961), rickardite (Cu4Te3), native tellurium sylvanite (AuAgTe4) and petzite Ag3AuTe2). Mining extended down-dip to 700 feet. At a depth of about 90 feet the workings are reported to have penetrated a body of native sulfur, which graded into massive pyrite at the water level, about 105 feet below the surface.

The Old Lot gold mine, about 3 miles north of Powderhorn, is developed by adits, stopes, drifts, and a 300-foot shaft along a series of thin quartz veins that form a stock-work in felsite porphyry near the contact with biotite syenite. The zone of gold-bearing quartz veins strikes east-northeast and is reported to be at least 500 feet long.

South and southeast of Spencer, the Headlight, Gunnison, Anaconda, and Ironcap Mines are in or near fractured and veined purplish-gray quartzite layers 5-24 feet thick. The Headlight mine was mined chiefly for its copper, and the other mines yielded small tonnages of gold-bearing ore. About one-half mile east of Midway, the Ute Trail mine is developed in a quartz vein along a nearly vertical breccia zone striking N. 80° E. near the contact of chloritized granite and felsite.

Niobium occurs in disseminated pyrochlore grains 0.5 to 1 mm across within the dolomitic carbonatite of Iron Hill. The pyrochlore is concentrated in the finer textured carbonatite and is also commonly associated with fluorapatite along shear planes in the carbonatite. Drilling in 1957 and 1958 indicated a reserve of more than 100,000 tons of Nb2O5 in carbonatite averaging at least 0.25 percent Nb2O5, a substantial amount of which averaged 0.35 percent Nb2O5. This reserve estimate was subsequently increased by underground work and additional drilling (Temple and Grogan, 1965, p. 673).

Titanium occurs as ilmenite and perovskite intergrowths with magnetite in segregations and dike-like bodies within the pyroxenite at Iron Hill. Analyses of 441 samples of drill cores taken by the U.S. Bureau of Mines (Rose and Shannon, 1960) indicate that the TiO2 content of the pyroxenite ranges from 0.3 to 11.9 percent and averages 5.85 percent. Local concentrations in magnetite-perovskite-ilmenite bodies contain as much as 40 percent TiO2. In sec. 3, southeast of Powderhorn on New Jersey Zinc Co. claims, a dike of magnetite-ilmenite-perovskite rock is about 150 feet thick, strikes N. 15° E., and extends for an undetermined distance beneath a capping of welded tuff.

Vermiculite is sporadically distributed in altered pyroxenite as segregations and in dike-like bodies. The vermiculite, apparently a weathering product of biotite in the pyroxenite, occurs in plates as much as 4 inches across, generally intergrown with coarse-grained diopside, apatite, and iron oxides. Most of the surface stripping for vermiculite has been between North Beaver and Deldorado Creeks and at the head of Stone Gulch.

Calcite and manganese oxide veins fill fractures in quartz-biotite schist on the Lucretia claims in sec. 4 along Wolf Creek. The manganese oxides, chiefly pyrolusite, form veins as much as 3 feet thick that strike N. 40°-65° W. over a length of about 600 feet.

Text from source map: Powderhorn Quadrangle

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Text from source map: Powderhorn Quadrangle

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This document was developed and completed by Stephanie O'Meara, James Winter, Sarah Lowe and Dylan Rolley (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Stephanie O'Meara and James Winter.

The information in this document was compiled from GRI source maps, and is intended to accompany the digital geologic-GIS maps and other digital data for Black Canyon of the Gunnison National Park and Curecanti National Recreation Area, Colorado (BLCA-CURE) developed by James Winter, Stephanie O'Meara, Sarah Lowe, Dylan Rolley and Dalton Meyer (Colorado State University; see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps.

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