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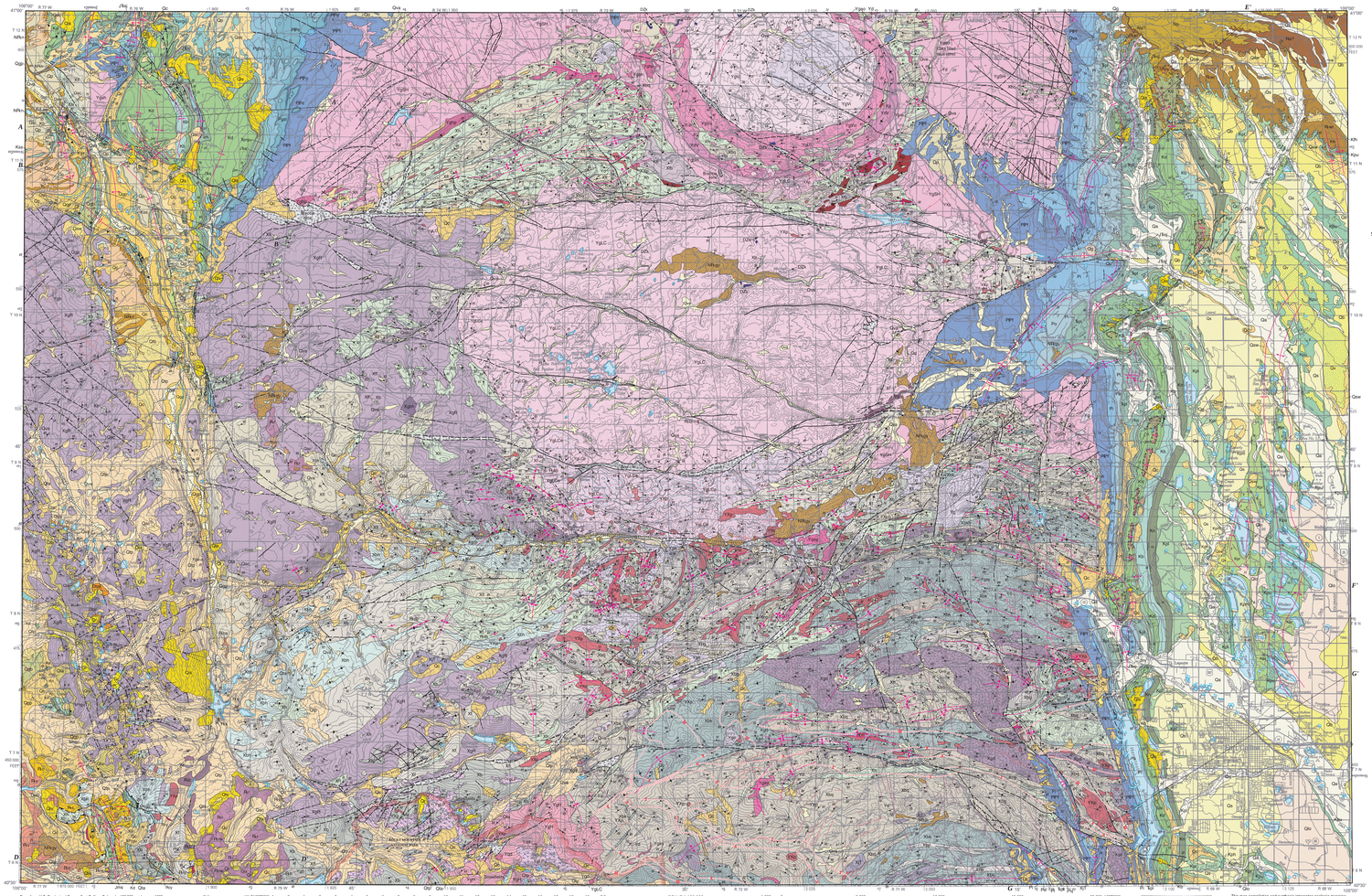
U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3399
Pamphlet accompanies map



Base from U.S. Geological Survey Fort Collins, Colorado 100,000-scale map, 1983
Universal Transverse Mercator projection, zone 13N
25,000-foot grid ticks based on Colorado coordinate system, north zone
1927 North American Datum of 1927 (NAD 27). To place on predicted North American Datum 1983, move the projection lines 6 meters north and 48 meters east
Rocky Mountain National Park boundary accessed on Dec. 20, 2017 at https://www.nps.gov/romo/
There may be private inholdings within the boundaries of the National or State reservations shown on this map
This map is not a legal document. Public lands are subject to change and leasing and may have access restrictions; check with appropriate offices. Obtain permission before entering private lands

KILOMETERS 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
MILES 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13

APPROXIMATE MEAN DECLINATION JANUARY 1, 2018
DECLINATION RANGE 8.7° TO 9.4° TO THE WEST WEST

SCALE 1:100 000
TRANSVERSE MERCATOR PROJECTION
REPRESENTATION OF A PLANE TANGENT TO THE GROUND
CONTOUR INTERVAL 50 METERS
SUPPLEMENTARY CONTOUR INTERVAL 25 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MAP LOCATION

This map compilation and synthesis integrates geologic mapping and various topical studies carried out between 1980 and 1986 under the U.S. Geological Survey (USGS) study of the northeastern Front Range, geologic mapping of Rocky Mountain National Park, and reconnaissance geologic mapping in wilderness areas. Much of the mapping is based on modern, detailed surveys and reconnaissance in previously unmapped areas of the quadrangle. This publication further draws on topical studies in geology, geophysics, and geochemistry conducted by numerous investigators from Federal, State, and local agencies, as well as university research published through the years.
Digital cartography and database by J.B. Workman
Digital topographic base prepared by T.R. Brandt
Publishing support provided by Denver Publishing Service Center
Edit and digital layout by L.J. Binder
Manuscript approved for publication February 22, 2018

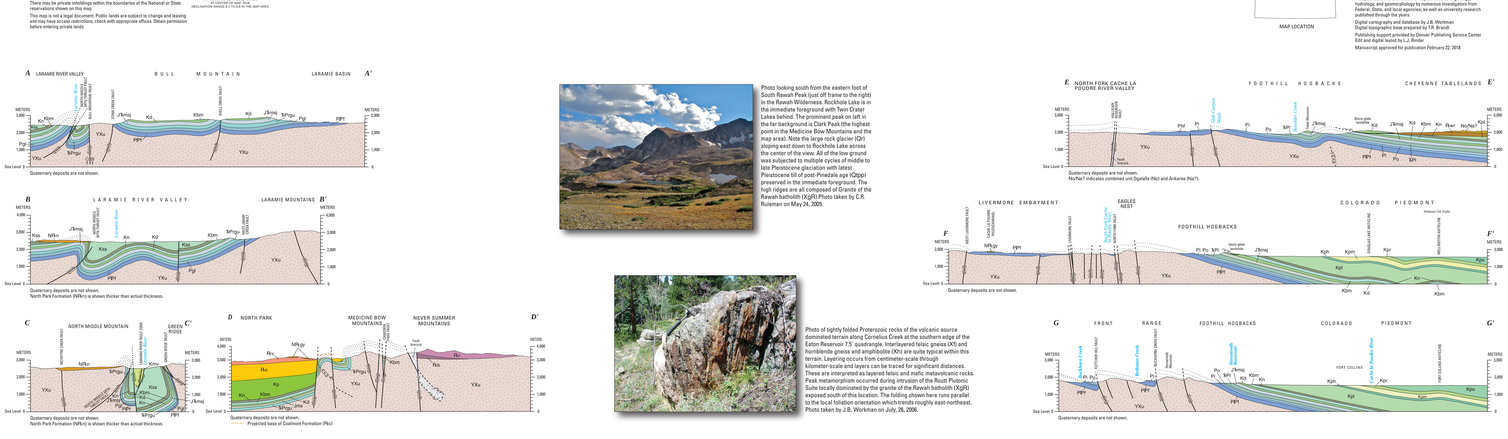
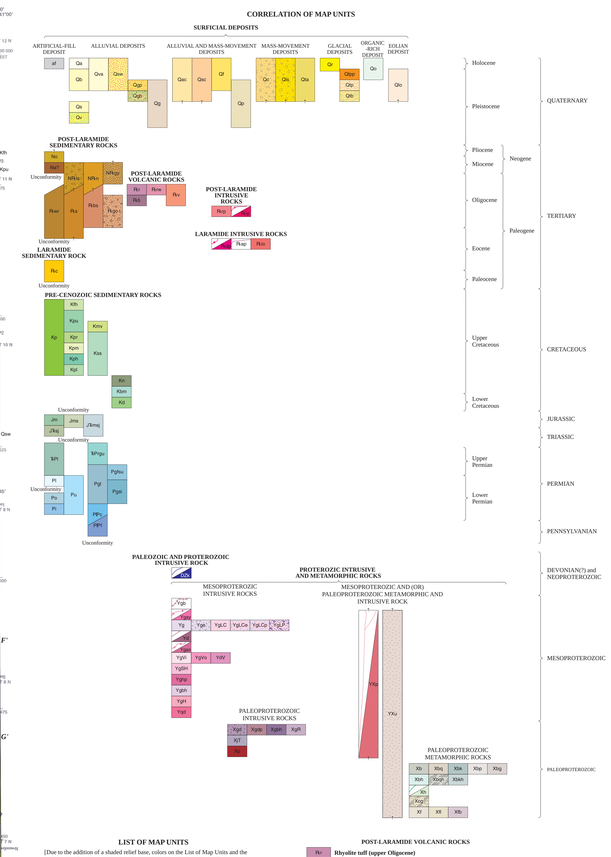


Photo looking south from the eastern foot of South Rawah Peak (just off frame to the right) in the Rawah Wilderness. Rockhole Lake is in the immediate foreground with Twin Crater Lakes behind. The prominent peak on left in the far background is Clark Peak (the highest point in the Medicine Bow Mountains and the map area). Note the large rock glacier (Qri) sloping east down to Rockhole Lake across the center of the view. All of the low ground was subjected to multiple cycles of middle to late Pleistocene glaciation with latest Pleistocene till of post-Pinedale age (Qtpp) preserved in the immediate foreground. The high ridges are all composed of Granite of the Rawah batholith (XgRi). Photo taken by C.R. Ruleman on May 24, 2005.

Photos of tightly folded Proterozoic rocks of the volcanic source dominated terrain along Cornelius Creek at the southern edge of the Eaton Reservoir 7.5' quadrangle. Interlayered felsic gneiss (XO) and hornblende gneiss and amphibolite (Xh) are quite typical within this terrain. Layering occurs from centimeter-scale through kilometer-scale and layers can be traced for significant distances. These are interpreted as layered felsic and mafic metavolcanic rocks. Peak metamorphism occurred during intrusion of the Routt Plutonic Suite locally dominated by the granite of the Rawah batholith (XgRi) exposed south of this location. The folding shown here runs parallel to the local foliation orientation which trends roughly east-northeast. Photo taken by J.B. Workman on July, 26, 2006.



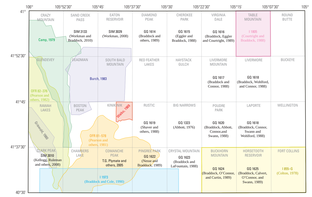


Figure 4. *A.* Index map showing sources of geologic-map data used in compiling the Fort Collins 30'×60' quadrangle. For U.S. Geological Survey publications, report number, authorship, and date of publication are shown.

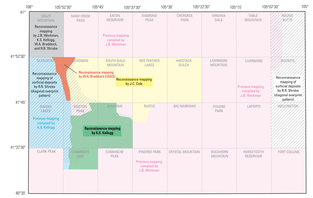
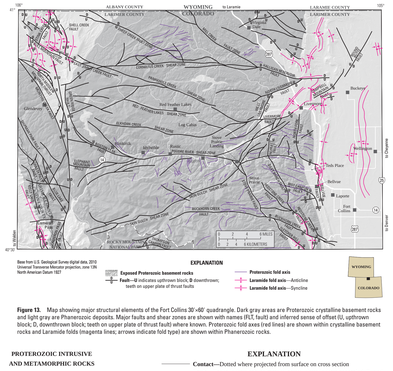


Figure 4. *B.* Index map of compilation responsibilities for new mapping in the Fort Collins 30'×60' quadrangle.



Base from U.S. Geological Survey digital data, 2012
Universal Transverse Mercator projection, zone 13N
North American Datum 1927

EXPLANATION

- Exposed Proterozoic basement rocks
- Fault—Ø indicates upthrown block, Ø downthrown; teeth on upper plate of thrust faults
- Proterozoic fold axis
- Laramide fold axis—Anticline
- Laramide fold axis—Syncline

WYOMING
COLORADO

Figure 13. Map showing major structural elements of the Fort Collins 30'×60' quadrangle. Dark gray areas are Proterozoic crystalline basement rocks and light gray are Phanerozoic deposits. Major faults and shear zones are shown with names (R/LT, fault) and inferred sense of offset (U, upthrown block; D, downthrown block; teeth on upper plate of thrust fault) where known. Proterozoic fold axes (red lines) are shown within crystalline basement rocks and Laramide folds (magenta lines; arrows indicate fold type) are shown within Phanerozoic rocks.

Geologic Map of the Fort Collins 30'×60' Quadrangle, Larimer and Jackson Counties, Colorado, and Albany and Laramie Counties, Wyoming

By
Jeremiah B. Workman, James C. Cole, Ralph R. Shroba, Karl S. Kellogg, and Wayne R. Premo
2018

LIST OF MAP UNITS

[Due to the addition of a shaded relief base, colors on the List of Map Units and the Correlation of Map Units may not exactly match unit colors on the map]

SURFICIAL DEPOSITS

ARTIFICIAL-FILL DEPOSIT

af — **Artificial fill (latest Holocene)**

ALLUVIAL DEPOSITS

Qa — **Valley-floor alluvium (Holocene)**
Qva — **Mountain-valley alluvium (Holocene and late Pleistocene)**
Qsw — **Sheetwash alluvium (Holocene and late Pleistocene)**
Qb — **Broadway alluvium (late Pleistocene)**
Qgp — **Terrace alluvium of Pinedale age (late Pleistocene)**
Qgb — **Terrace alluvium of Bull Lake age (late and middle Pleistocene)**
Qg — **Gravelly stream alluvium (late and middle Pleistocene)**
Qs — **Slocum Alluvium (middle Pleistocene)**
Qv — **Verdos Alluvium (middle Pleistocene)**

ALLUVIAL AND MASS-MOVEMENT DEPOSITS

Qac — **Alluvium and colluvium, undivided (Holocene to middle? Pleistocene)**
Qsc — **Sheetwash alluvium and colluvium, undivided (Holocene to middle? Pleistocene)**
Qf — **Fan deposits (Holocene and late Pleistocene)**
Qp — **Pediment deposits (late and middle Pleistocene)**

MASS-MOVEMENT DEPOSITS

Qc — **Colluvium (Holocene to middle? Pleistocene)**
Qls — **Landslide deposits (Holocene to middle? Pleistocene)**
Qta — **Talus deposits (Holocene to middle? Pleistocene)**

GLACIAL DEPOSITS

Qr — **Rock-glacier deposits (Holocene and latest Pleistocene)**
Qtpp — **Till of post-Pinedale age (latest Pleistocene)**
Qtp — **Till of Pinedale age (late Pleistocene)**
Qtb — **Till of Bull Lake age (late and middle Pleistocene)**

ORGANIC-RICH DEPOSIT

Qo — **Organic-rich sediment (Holocene and latest Pleistocene)**

EOLIAN DEPOSIT

Qto — **Loess (late and late middle? Pleistocene)**

POST-LARAMIDE SEDIMENTARY ROCKS

Nsc — **Sedimentary rocks, undivided (Oligocene and Eocene?)**
Ntf — **Tuffaceous sandstone and basalt (Oligocene)**
Ntgc — **Older high-level fluvial gravel (Oligocene)**
Nhr — **Rhyolite tuff (upper Oligocene)**
Nhw — **Rhyolite welded tuff (upper Oligocene)**
Nv — **Volcanic rocks, undivided (Oligocene)**
Nb — **Basalt (Oligocene)**

POST-LARAMIDE INTRUSIVE ROCKS

Nsp — **Rhyolite porphyry and felsite (Oligocene)**
Ni — **Younger intrusive rocks, undivided (Oligocene)**

LARAMIDE INTRUSIVE ROCKS

Kpd — **Dacite porphyry (Eocene)**
Kap — **Andesite porphyry (Eocene)**
Kio — **Older intrusive rocks, undivided (Eocene)**

LARAMIDE SEDIMENTARY ROCK

Ku — **Coalmont Formation (Eocene and Paleocene)**

PRE-CENOZOIC SEDIMENTARY ROCKS

Kfh — **Fox Hills Sandstone (Upper Cretaceous)**
Kp — **Pierre Shale, undivided (Upper Cretaceous)**
Kpu — **Upper shale member**
Kpr — **Richard Sandstone Member, Larimer Sandstone Member, Rocky Ridge Sandstone Member and two intervening unnamed shale members**
Kpm — **Middle shale member**
Kph — **Hygiene Sandstone Member**
Kpl — **Lower shale member**
Kmv — **Mesaverde Formation (Upper Cretaceous)**
Kss — **Steele Shale (Upper Cretaceous)**
Kn — **Niobrara Formation (Upper Cretaceous)**
Kbm — **Benton Group (Upper and Lower Cretaceous)**
Kd — **Dakota Group (Lower Cretaceous)**
Jft — **Morrison Formation (Upper Jurassic)**
Jms — **Morrison Formation (Upper Jurassic) and Sundance Formation (Upper and Middle Jurassic), undivided**
JTRmj — **Morrison (Upper Jurassic), Sundance (Upper and Middle Jurassic), and Jelm (Upper Triassic) Formations, undivided**— Shown in cross sections only
JTRsj — **Sundance (Upper and Middle Jurassic) and Jelm (Upper Triassic) Formations, undivided**
ŦPl — **Lykins Formation (Lower Triassic and Upper Permian)**
Pl — **Lyons Sandstone (Lower Permian)**
Pu — **Lyons Sandstone and Owl Canyon and Ingleside Formations, undivided (Lower Permian)**
Pio — **Owl Canyon Formation (Lower Permian)**
Pi — **Ingleside Formation (Lower Permian)**
ŦPmp — **Red Peak Formation (Lower Triassic) and upper part of Goose Egg Formation (Lower Triassic and Upper Permian), undivided**
PIPg — **Lower part of Goose Egg Formation (Upper and Lower Permian)**— Shown on cross sections only
PIPgfu — **Forelle Limestone Member (Upper Permian) and upper part of Satanka Shale Member (Upper and Lower Permian), undivided**
PIPgsl — **Lower part of Satanka Shale Member (Lower Permian)**
PIPc — **Casper Formation (Lower Permian to Middle Pennsylvanian)**
PIPf — **Fountain Formation (Lower Permian to Lower Pennsylvanian)**

PALEOZOIC AND PROTEROZOIC INTRUSIVE ROCK

Ki — **Kimberlite (Devonian? and Neoproterozoic)**

POST-LARAMIDE VOLCANIC ROCKS

Rhr — **Rhyolite tuff (upper Oligocene)**
Rhw — **Rhyolite welded tuff (upper Oligocene)**
Rv — **Volcanic rocks, undivided (Oligocene)**
Rb — **Basalt (Oligocene)**

POST-LARAMIDE INTRUSIVE ROCKS

Rsp — **Rhyolite porphyry and felsite (Oligocene)**
Ri — **Younger intrusive rocks, undivided (Oligocene)**

LARAMIDE INTRUSIVE ROCKS

Rpd — **Dacite porphyry (Eocene)**
Rap — **Andesite porphyry (Eocene)**
Rio — **Older intrusive rocks, undivided (Eocene)**

LARAMIDE SEDIMENTARY ROCK

Ru — **Coalmont Formation (Eocene and Paleocene)**

PRE-CENOZOIC SEDIMENTARY ROCKS

Kfh — **Fox Hills Sandstone (Upper Cretaceous)**
Kp — **Pierre Shale, undivided (Upper Cretaceous)**—On cross section *D–D'* only
Kpu — **Upper shale member**
Kpr — **Richard Sandstone Member, Larimer Sandstone Member, Rocky Ridge Sandstone Member and two intervening unnamed shale members**
Kpm — **Middle shale member**
Kph — **Hygiene Sandstone Member**
Kpl — **Lower shale member**
Kmv — **Mesaverde Formation (Upper Cretaceous)**
Kss — **Steele Shale (Upper Cretaceous)**
Kn — **Niobrara Formation (Upper Cretaceous)**
Kbm — **Benton Group (Upper and Lower Cretaceous)**
Kd — **Dakota Group (Lower Cretaceous)**
Jft — **Morrison Formation (Upper Jurassic)**
Jms — **Morrison Formation (Upper Jurassic) and Sundance Formation (Upper and Middle Jurassic), undivided**
JTRmj — **Morrison (Upper Jurassic), Sundance (Upper and Middle Jurassic), and Jelm (Upper Triassic) Formations, undivided**— Shown in cross sections only
JTRsj — **Sundance (Upper and Middle Jurassic) and Jelm (Upper Triassic) Formations, undivided**
ŦPl — **Lykins Formation (Lower Triassic and Upper Permian)**
Pl — **Lyons Sandstone (Lower Permian)**
Pu — **Lyons Sandstone and Owl Canyon and Ingleside Formations, undivided (Lower Permian)**
Pio — **Owl Canyon Formation (Lower Permian)**
Pi — **Ingleside Formation (Lower Permian)**
ŦPmp — **Red Peak Formation (Lower Triassic) and upper part of Goose Egg Formation (Lower Triassic and Upper Permian), undivided**
PIPg — **Lower part of Goose Egg Formation (Upper and Lower Permian)**
PIPgfu — **Forelle Limestone Member (Upper Permian) and upper part of Satanka Shale Member (Upper and Lower Permian), undivided**
PIPgsl — **Lower part of Satanka Shale Member (Lower Permian)**
PIPc — **Casper Formation (Lower Permian to Middle Pennsylvanian)**
PIPf — **Fountain Formation (Lower Permian to Lower Pennsylvanian)**

PALEOZOIC AND PROTEROZOIC INTRUSIVE ROCK

Ki — **Kimberlite (Devonian? and Neoproterozoic)**

PROTEROZOIC INTRUSIVE AND METAMORPHIC ROCKS

MESOPROTEROZOIC INTRUSIVE ROCKS

YgC — **Gabbro of the Iron dike**
Yg — **Younger aplite dikes and plugs**
Yg — **Biotite granite**
YgLC — **Equigranular biotite granite**
YgLCp — **Granite of Log Cabin batholith**
YgLC — **Granite of Log Cabin batholith, undivided**
YgLCe — **Equigranular granite of Log Cabin batholith**
YgLCp — **Porphyritic granite of Log Cabin batholith**
YgLP — **Granite of Longs Peak**
Ym — **Mafic dikes and plugs**
Ydr — **Older aplite dikes and plugs**
Virginia Dale ring-dike complex
YgVi — **Inner cap rock monzogranite of the Virginia Dale ring-dike complex**
YgVo — **Outer cap rock monzogranite of the Virginia Dale ring-dike complex**
Ydi — **Diorite and hybrid rocks of the Virginia Dale ring-dike complex**
YgSh — **Sherman Granite**
YgHp — **Hornblende granite-porphyry**
YgGb — **Hornblende gabbro**
YgGr — **Granite of Hagues Peak**
Yqz — **Quartz diorite**

MESOPROTEROZOIC AND (OR) PALEOPROTEROZOIC INTRUSIVE AND METAMORPHIC ROCK

Yp — **Pegmatite**
YXu — **Undivided intrusive and metamorphic rocks**—Cross sections only

PALEOPROTEROZOIC INTRUSIVE ROCKS

XgR — **Granodiorite**
XgRp — **Porphyritic granodiorite**
XgRh — **Hornblende gabbro**
XgRi — **Granite of the Rawah batholith**
XT — **Trondhjemite of Thompson Canyon**
Xp — **Gneissic pegmatite**

PALEOPROTEROZOIC METAMORPHIC ROCKS

Xb — **Biotite schist and gneiss**
Xbq — **Quartzofeldspathic mica schist**
Xbk — **Kaunted mica schist**
Xbp — **Porphyroblastic biotite schist**
Xbg — **Granoblastic quartzofeldspathic biotite gneiss**
Xbh — **Biotite gneiss and hornblende gneiss, undivided**
XbqO — **Quartzofeldspathic mica schist and hornblende gneiss, undivided**
XbkH — **Kaunted mica schist and hornblende gneiss, undivided**
Xh — **Hornblende gneiss and amphibolite**
XhC — **Calc-silicate gneiss**
Xf — **Felsic gneiss**
Xl — **Leucocratic felsic gneiss**
Xfb — **Biotite felsic gneiss**

EXPLANATION

Contact—Dotted where projected from surface on cross section

Fault—Dashed where approximately located, dotted where concealed. Dotted where projected from surface on cross section. Queried where existence or identity is questionable

Low-angle normal fault—Dotted where location approximate, dotted where concealed. Half-circles on downthrown block

Thrust fault—Dashed where approximately located; dotted where concealed. Teeth on hanging wall

Joint—Location approximate

Anticline—Arrows show direction of dip

Overturned anticline—Beds on one limb are overturned; arrows show dip direction of limbs

Antiform—In Proterozoic rocks. Arrows show direction of dip

Monocline—Arrow shows direction of dip

Monocline, anticlinal bend—Arrows show direction of dip; shorter arrow on steeper limb

Monocline, synclinal bend—Arrows show direction of dip; shorter arrow on steeper limb

Syncline—Arrows show direction of dip

Overturned syncline—Beds on one limb are overturned; arrows show dip direction of limbs

Synform—In Proterozoic rocks. Arrows show direction of dip

Metamorphic reaction isograd lines—Boundary of a metamorphic zone representing the first appearance (in) or disappearance (out) of a metamorphic index mineral

Metamorphic reaction isograds
- **Sillimanite in**
- **Andalusite, cordierite, and garnet out**
- **Potassium feldspar in, lepidoblastic muscovite out**
- **Migmatite in**

Fluvial terrace scarp—Hachures point down scarp

Rocky Mountain National Park boundary

Key Beds

- **Rhyolite welded tuff (Ŧ/Ŧw)**
- **Lyons Sandstone (Ŧl)**
- **Ingleside Formation (Ŧi)**
- **Casper Formation (ŦPIPc)**

PLANAR POINT FEATURES

Bedding and foliation

- **Horizontal bedding**
- **Inclined bedding**—Showing strike and dip
- **Inclined bedding**—Showing approximate strike and direction of dip
- **Vertical bedding**—Showing strike
- **Overturned bedding**—Showing strike and dip
- **Inclined foliation**—Showing strike and dip
- **Vertical foliation**—Showing strike

AREAL FEATURES

- **Glacier or permanent snowfield**
- **Water body**
- **Boundary of block-glide landslide**—Dashed where approximately located; dotted where concealed. Glide mass area is represented by a "broken block" pattern and coherent stratigraphic units are shown within the glide mass where present. Hachures point towards glide mass area
- **Breccia zone**—Dashed where location is approximate

Selected Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
Area		
square kilometer (km²)	0.3861	square mile (mi²)

U.S. customary units to International System of Units

Multiply	By	To obtain
Length		
inch (in)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
acre	4,047	square meter (m²)

Altitude, as used in this report, refers to distance above sea level.

Divisions of Quaternary, Neogene, and Paleogene time used in this report

Period or subperiod	Epoch		Age
Quaternary	Holocene		0–11.5 ka
	Pleistocene	late	11.5–126 ka
		middle	126–781 ka
		early	781 ka–2.588 Ma
Neogene	Pliocene		2.588–5.332 Ma
	Miocene		5.332–23.03 Ma
Paleogene	Oligocene		23.03–33.9 Ma
	Eocene		33.9–56.0 Ma
	Paleocene		56.0–66 Ma

Ages of rock boundaries are those of the U.S. Geological Survey Geologic Names Committee (2010) except those for the late middle Pleistocene boundary and middle-late Pleistocene boundary, which are based on Marine Isotope Stage boundaries. Ages are expressed in ka for kilo-annum (thousand years) and Ma for mega-annum (million years).

For more information concerning the research in this report, contact the Center Director, USGS Geosciences and Environmental Change Science Center, Denver Federal Center, Bldg 20, MS 980, Denver, CO 80225, (303) 236-1844

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