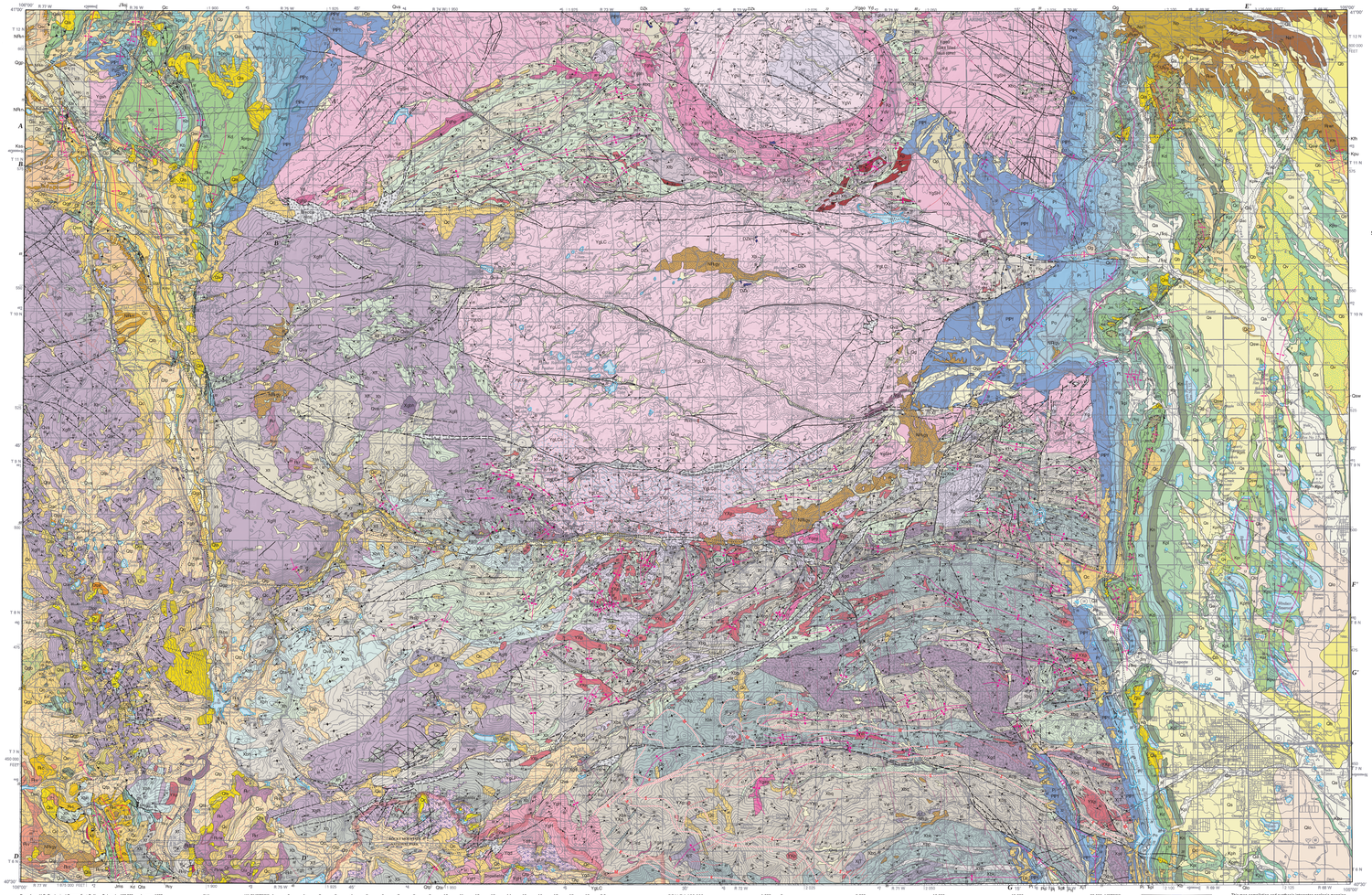
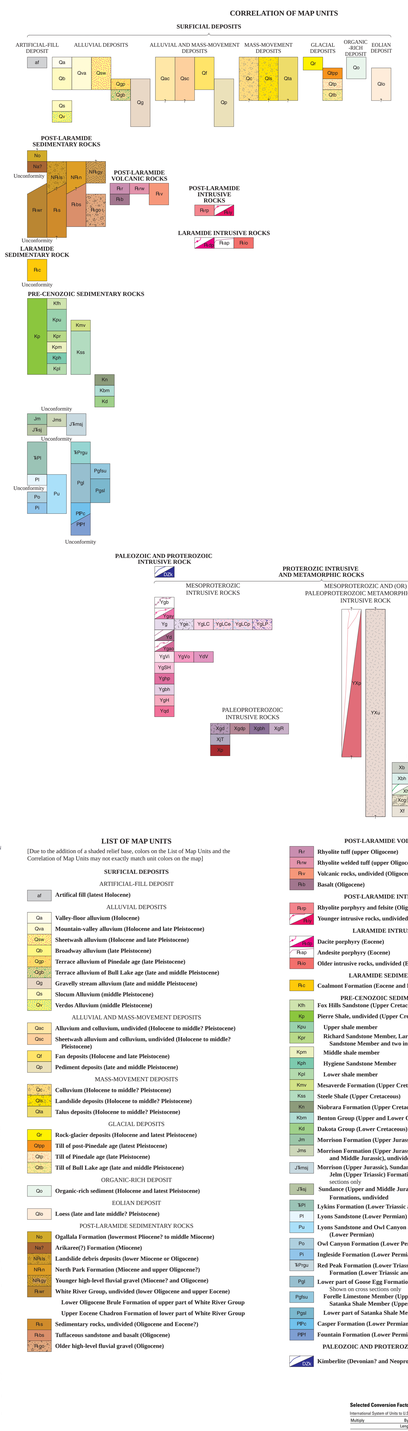
U.S. Department of the Interior
U.S. Geological Survey

Scientific Investigations Map 3399
Pamphlet accompanies map



CORRELATION OF MAP UNITS



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)**
Qtw — **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)**
Qac — **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)**
Qmc — **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

Ngc — **Ogallala Formation (lowermost Pliocene? to middle Miocene)**
Ngt — **Arikaree(?) Formation (Miocene)**
NPch — **Landslide debris deposits (lower Miocene or Oligocene)**
NPkn — **North Park Formation (Miocene and Oligocene)**
NPcp — **Younger high-level fluvial gravel (Miocene? and Oligocene)**
Rwr — **White River Group, undivided (lower Oligocene and upper Eocene)**
Lower Oligocene Brule Formation of upper part of White River Group
Upper Eocene Chadron Formation of lower part of White River Group
Rcs — **Sedimentary rocks, undivided (Oligocene and Eocene?)**
Tcf — **Toffaceous sandstone and basalt (Oligocene)**
Tcgp — **Older high-level fluvial gravel (Oligocene)**

POST-LARAMIDE VOLCANIC ROCKS

Rlr — **Rhyolite tuff (upper Oligocene)**
Rlrw — **Rhyolite welded tuff (upper Oligocene)**
Rv — **Volcanic rocks, undivided (Oligocene)**
Rtc — **Basalt (Oligocene)**

POST-LARAMIDE INTRUSIVE ROCKS

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

LARAMIDE INTRUSIVE ROCKS

Dacite porphyry (Eocene)
Andesite porphyry (Eocene)
Rkic — **Older intrusive rocks, undivided (Eocene)**

LARAMIDE SEDIMENTARY ROCK

Rcu — **Coalmont Formation (upper and Paleocene)**

PRE-CENOZOIC SEDIMENTARY ROCKS

Kfh — **Fox Hills Sandstone (Upper Cretaceous)**
Kpi — **Pierre Shale, undivided (Upper Cretaceous)**—On cross section *D–D'* only
Upper shale member
Richard Sandstone Member, Larimer Sandstone Member, Rocky Ridge Sandstone Member and two intervening unnamed shale members
Middle shale member
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)**
Jm — **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**
lPh — **Lykins Formation (Lower Triassic and Upper Permian)**
Pl — **Lyons Sandstone (Lower Permian)**
Pu — **Lyons Sandstone and Owl Canyon and Ingleside Formations, undivided (Lower Permian)**
Po — **Owl Canyon Formation (Lower Permian)**
Pi — **Ingleside Formation (Lower Permian)**
lPmgu — **Red Peak Formation (Lower Triassic) and upper part of Goose Egg Formation (Lower Triassic and Upper Permian), undivided**
Pgl — **Lower part of Goose Egg Formation (Upper and Lower Permian)**—Shown on cross sections only
Pgfau — **Forelle Limestone Member (Upper Permian) and upper part of Satanka Shale Member (Upper and Lower Permian), undivided**
Pgsl — **Lower part of Satanka Shale Member (Lower Permian)**
PPc — **Casper Formation (Lower Permian to Middle Pennsylvanian)**
PIPf — **Fountain Formation (Lower Permian to Lower Pennsylvanian)**

PALEOZOIC AND PROTEROZOIC INTRUSIVE ROCK

Kimberlite (Devonian? and Neoproterozoic)

PROTEROZOIC INTRUSIVE AND METAMORPHIC ROCKS

MESOPROTEROZOIC INTRUSIVE ROCKS

Ygc — **Gabbro of the Iron dike**
Younger aplite dikes and plugs
Yg — **Biotite granite**
Epigranular biotite granite
Granite of Log Cabin batholith
Yglc — **Granite of Log Cabin batholith, undivided**
Yglc,Cs — **Equigranular granite of Log Cabin batholith**
Yglc,Cp — **Porphyritic granite of Log Cabin batholith**
Ygl,P — **Granite of Longs Peak**
Mafic dikes and plugs
Older aplite dikes and plugs
Virginia Dale ring-dike complex
Yglci — **Inner cap rock monzogranite of the Virginia Dale ring-dike complex**
Yglco — **Outer cap rock monzogranite of the Virginia Dale ring-dike complex**
Yglv — **Dioritic and hybrid rocks of the Virginia Dale ring-dike complex**
Ygsh — **Sherman Granite**
Yghp — **Hornblende granite porphyry**
Ygbh — **Hornblende gabbro**
Ygd — **Granite of Hagues Peak**
Yqd — **Quartz diorite**

MESOPROTEROZOIC AND (OR) PALEOPROTEROZOIC INTRUSIVE AND METAMORPHIC ROCK

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

PALEOPROTEROZOIC INTRUSIVE ROCKS

Xgd — **Granodiorite**
Xgdp — **Porphyritic granodiorite**
Xgbh — **Hornblende gabbro**
Xgb — **Granite of the Rawah batholith**
XT — **Trondhjemite of Thompson Canyon**
Xn — **Gneissic pegmatite**

PALEOPROTEROZOIC METAMORPHIC ROCKS

Xb — **Biotite schist and gneiss**
Xbq — **Quartzofeldspathic mica schist**
Xbk — **Knotted mica schist**
Xbp — **Porphyroblastic biotite schist**
Xbg — **Granoblastic quartzofeldspathic biotite gneiss**
Xbh — **Biotite gneiss and hornblende gneiss, undivided**
Xbgq — **Quartzofeldspathic mica schist and hornblende gneiss, undivided**
Xbkh — **Knotted mica schist and hornblende gneiss, undivided**
Xh — **Hornblende gneiss and amphibolite**
Xcg — **Calc-silicate gneiss**
Xf — **Felsic gneiss**
Xfl — **Leucocratic felsic gneiss**
Xfb — **Biotite felsic gneiss**

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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—Dashed where location approximate, dotted where concealed. Hall-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
Sillimanite in
Andalusite, cordierite, and garnet out
Potassium feldspar in, hypidiblastic muscovite out
Migmatite in
Fluvial terrace scarp—Hachures point down scarp
Rocky Mountain National Park boundary

Key Beds
Rhyolite welded tuff (Rlrw)
Lyons Sandstone (Pl)
Ingleside Formation (Pi)
Casper Formation (PPc)

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

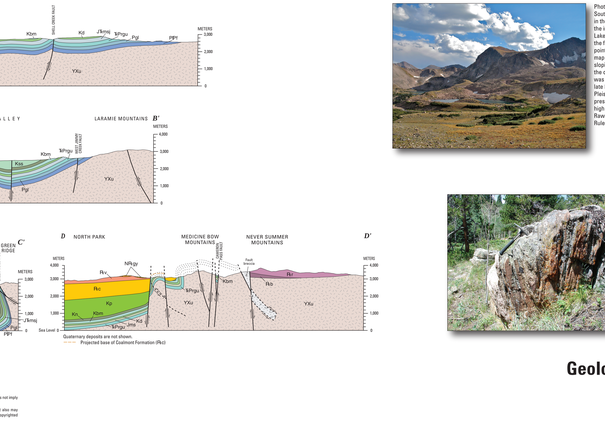

Photo looking south from the eastern foot of South Rawah Peak (just off frame to the right) in the Rawah Wilderness. Rockhole Lake is in the immediate foreground with Twin Crater Lakes behind. The prominent peak on left in the far background is Clark Peak (the highest point in the Medicine Bow Mountains and the map area). Note the large rock glacier (Qr) sloping east down to Rockhole Lake across the center of the view. All of the low ground was subject 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 (XgR).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 (Xf) 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 (XgR) 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.

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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

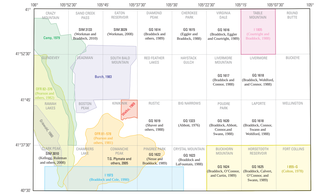

Figure 4. *A*, Index map showing sources of geologic-map data used in compiling the Fort Collins 30'×60' quadrangle. For U.S. Geological Survey publications, report number, authorship, and date of publication are shown.

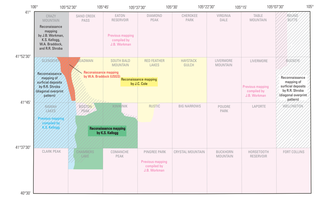

Figure 4. *B*, Index map of compilation responsibilities for new mapping in the Fort Collins 30'×60' quadrangle.



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 (RLT, 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.

EXPLANATION

Exposed Proterozoic basement rocks
Fault—U indicates upthrown block; D downthrown; teeth on upper plate of thrust faults
Proterozoic fold axis
Laramide fold axis—Anticline
Laramide fold axis—Syncline
WYOMING
COLORADO

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 (km^2)	0.3861	square mile (mi^2)

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 (m^2)

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 and middle	11.5–132 ka
	Pleistocene, early	132–788 ka
		788 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	56.0–63.3 Ma

Ages of time boundaries are those of the U.S. Geological Survey Geologic Names Committee (2010) except those for the late-middle Pleistocene boundary and middle-early Pleistocene boundary, which are those of Richmond and Fullerton (1986). 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 Box 25046, Mail Stop 980
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Or visit the Geosciences and Environmental Change Science Center website at https://www.usgs.gov/centers/gecsc

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ScienceBase data release (GIS and other files that support this report are available at https://doi.org/10.5066/F7GM7PVT

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