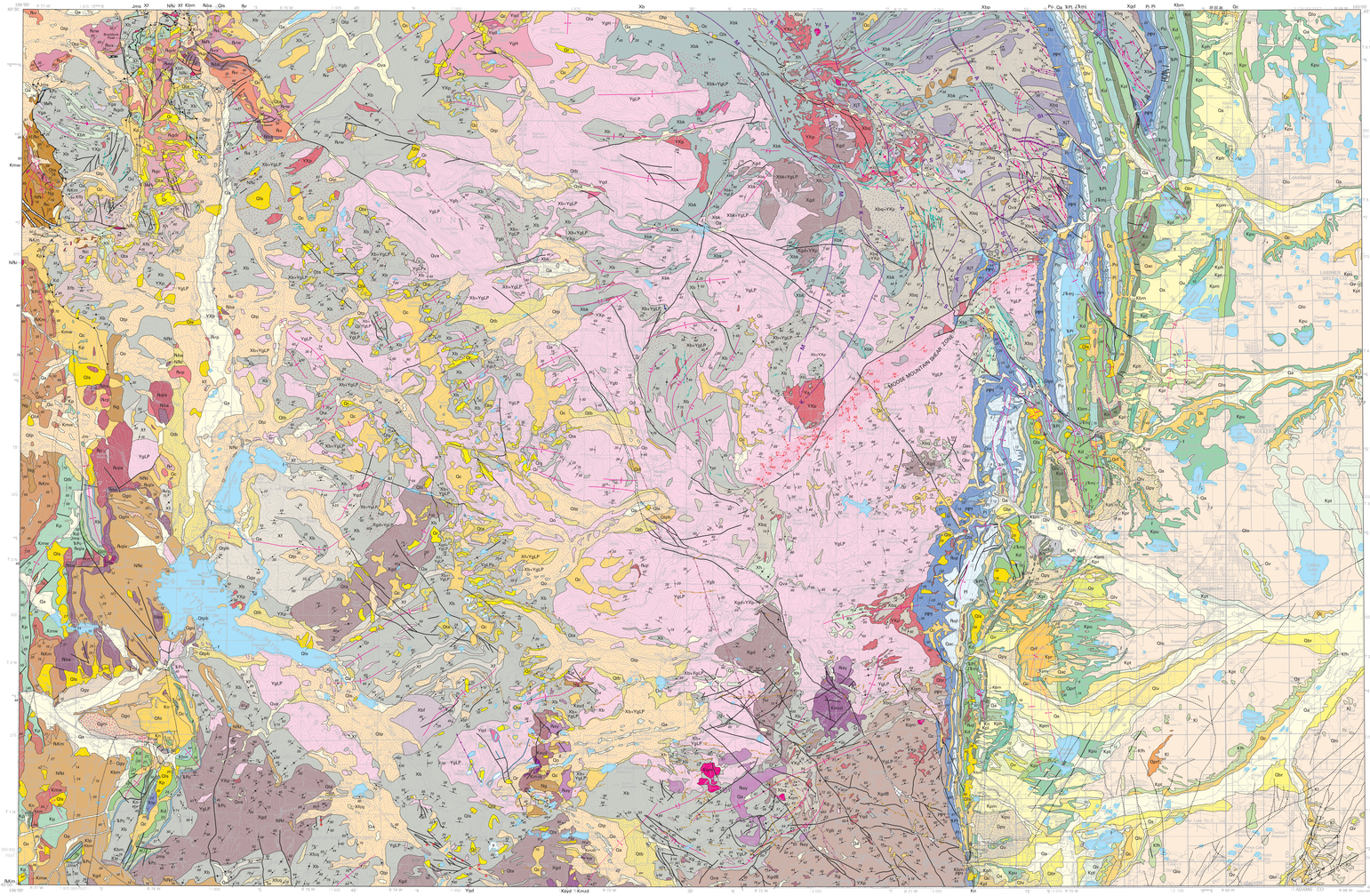
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SCIENTIFIC INVESTIGATIONS MAP 3039
Pamphlet accompanies map



Base from U.S. Geological Survey, 1984
Projection and 10,000-meter grid, zone 13
Universal Transverse Mercator
25,000-foot grid ticks based on Colorado coordinate system, north zone
1927 North American Datum

APPROXIMATE MEAN DECLINATION, 1984

SCALE 1:100 000

0 1 2 3 4 5 6 7 8 MILES
1 0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

CONTOUR INTERVAL 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

COLORADO
QUADRANGLE LOCATION

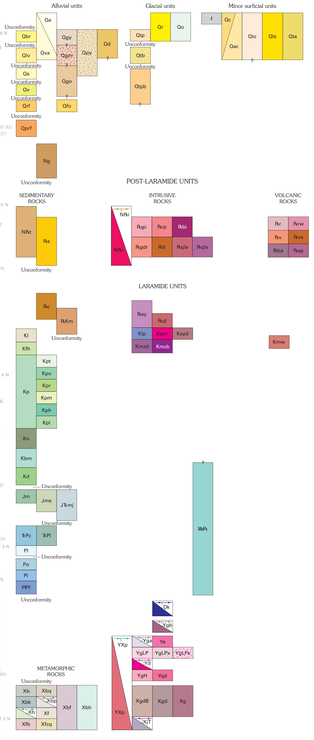
Geology compiled chiefly by W.A. Braddock from 1989–1995. Geology revised and updated by J.C. Cole from 2005–2006.

Digital map database prepared by Theodore R. Brandt
Photographs by Frederick C. Brunstein

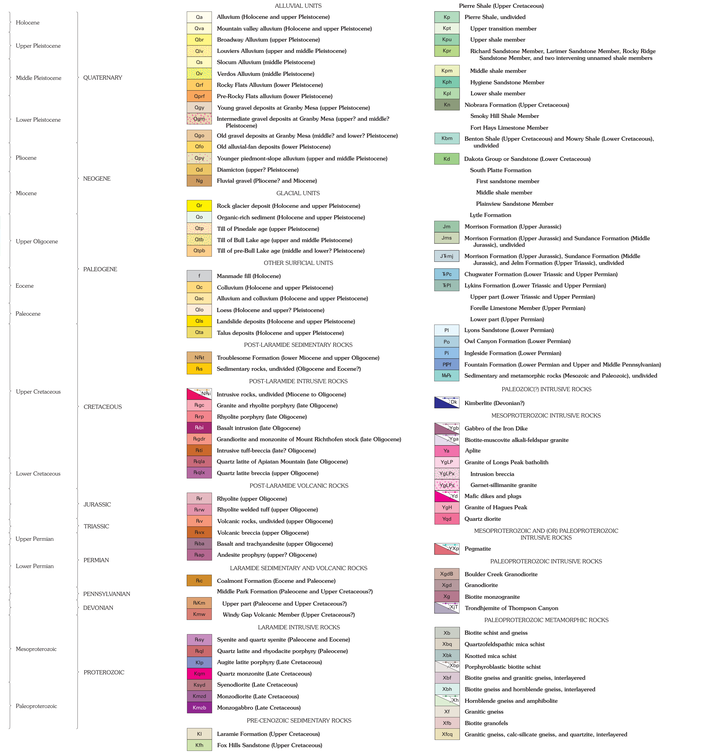
Editing and digital cartography by
Gayle M. Dumoncheaux,
Denver Publishing Service Center

Manuscript approved for publication July 11, 2008

CORRELATION OF MAP UNITS



LIST OF MAP UNITS



ALLUVIAL UNITS
- Qa — Alluvium (Holocene and upper Pleistocene)
- Qva — Mountain valley alluvium (Holocene and upper Pleistocene)
- Qbr — Broadway Alluvium (upper Pleistocene)
- Qlv — Louviers Alluvium (upper and middle Pleistocene)
- Qs — Slocum Alluvium (middle Pleistocene)
- Qv — Verdos Alluvium (middle Pleistocene)
- Qrf — Rocky Flats Alluvium (lower Pleistocene)
- Qparf — Pre-Rocky Flats alluvium (lower Pleistocene)
- Qgy — Young gravel deposits at Granby Mesa (upper Pleistocene)
- Qgm — Intermediate gravel deposits at Granby Mesa (upper? and middle? Pleistocene)
- Qgo — Old gravel deposits at Granby Mesa (middle? and lower? Pleistocene)
- Qfo — Old alluvial-fan deposits (lower Pleistocene)
- Qpy — Younger piedmont-slope alluvium (upper and middle Pleistocene)
- Qd — Diamicton (upper? Pleistocene)
- Ng — Fluvial gravel (Pliocene? and Miocene)

GLACIAL UNITS
- Qr — Rock glacier deposit (Holocene and upper Pleistocene)
- Qo — Organic-rich sediment (Holocene and upper Pleistocene)
- Qtp — Till of Pinedale age (upper Pleistocene)
- Qtb — Till of Bull Lake age (upper and middle Pleistocene)
- Qtpb — Till of pre-Bull Lake age (middle and lower? Pleistocene)

OTHER SURFICIAL UNITS
- f — Manmade fill (Holocene)
- Qc — Colluvium (Holocene and upper Pleistocene)
- Qac — Alluvium and colluvium (Holocene and upper Pleistocene)
- Qlo — Loess (Holocene and upper? Pleistocene)
- Qls — Landslide deposits (Holocene and upper Pleistocene)
- Qta — Talus deposits (Holocene and upper Pleistocene)

POST-LARAMIDE SEDIMENTARY ROCKS
- NfNt — Troublesome Formation (lower Miocene and upper Oligocene)
- Ns — Sedimentary rocks, undivided (Oligocene and Eocene?)

POST-LARAMIDE INTRUSIVE ROCKS
- Tvi — Intrusive rocks, undivided (Miocene to Oligocene)
- Rvgc — Granite and rhyolite porphyry (late Oligocene)
- Rvrp — Rhyolite porphyry (late Oligocene)
- Rvba — Basalt intrusion (late Oligocene)
- Rvgd — Granodiorite and monzonite of Mount Richthofen stock (late Oligocene)
- Rvti — Intrusive tuff-breccia date? Oligocene)
- Rvgl a — Quartz latite of Apiatan Mountain (late Oligocene)
- Rvgl v — Quartz latite breccia (upper Oligocene)

POST-LARAMIDE VOLCANIC ROCKS
- Rv — Rhyolite (upper Oligocene)
- Rvw — Rhyolite welded tuff (upper Oligocene)
- Rvv — Volcanic rocks, undivided (upper Oligocene)
- Rvvx — Volcanic breccia (upper Oligocene)
- Rvba — Basalt and trachyandesite (upper Oligocene)
- Rvap — Andesite prophyry (upper? Oligocene)

LARAMIDE SEDIMENTARY AND VOLCANIC ROCKS
- Rvc — Coalmont Formation (Eocene and Paleocene)
- Middle Park Formation (Paleocene and Upper Cretaceous?)
- RvKm — Upper part (Paleocene and Upper Cretaceous?)
- Kmw — Windy Gap Volcanic Member (Upper Cretaceous?)

LARAMIDE INTRUSIVE ROCKS
- Rvsy — Syenite and quartz syenite (Paleocene and Eocene)
- Rvql — Quartz latite and rhyodacite porphyry (Paleocene)
- Rvgl — Augite latite porphyry (Late Cretaceous)
- Kqm — Quartz monzonite (Late Cretaceous)
- Kmyd — Symodiorite (Late Cretaceous)
- Kmyd — Monzodiorite (Late Cretaceous)
- Kmgb — Monzogabbro (Late Cretaceous)

PRE-CENOZOIC SEDIMENTARY ROCKS
- Kl — Laramie Formation (Upper Cretaceous)
- Kfh — Fox Hills Sandstone (Upper Cretaceous)
- Pierre Shale (Upper Cretaceous)
- Kp — Pierre Shale, undivided
- Kpt — Upper transition member
- 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
- Kn — Niobrara Formation (Upper Cretaceous)
- Smoky Hill Shale Member
- Fort Hays Limestone Member
- Kbm — Benton Shale (Upper Cretaceous) and Mowry Shale (Lower Cretaceous), undivided
- Kd — Dakota Group or Sandstone (Lower Cretaceous)
- South Platte Formation
- Fluvial sandstone member
- Middle shale member
- Plainview Sandstone Member
- Lytle Formation
- Jm — Morrison Formation (Upper Jurassic)
- Jmsj — Morrison Formation (Upper Jurassic) and Sundance Formation (Middle Jurassic), undivided
- J'Rmj — Morrison Formation (Upper Jurassic), Sundance Formation (Middle Jurassic), and Jelm Formation (Upper Triassic), undivided
- TrPc — Chugwater Formation (Lower Triassic and Upper Permian)
- lym — Lykins Formation (Lower Triassic and Upper Permian)
- Upper part (Lower Triassic and Upper Permian)
- Forelle Limestone Member (Upper Permian)
- Lower part (Upper Permian)
- Pl — Lyons Sandstone (Lower Permian)
- Po — Owl Canyon Formation (Lower Permian)
- Pi — Ingleside Formation (Lower Permian)
- PIPf — Fountain Formation (Lower Permian and Upper and Middle Pennsylvanian)
- MzPz — Sedimentary and metamorphic rocks (Mesozoic and Paleozoic), undivided

PALEOZOIC(?) INTRUSIVE ROCKS
- Kimberlite (Devonian?)

MESOPROTEROZOIC INTRUSIVE ROCKS
- Gabbro of the Iron Dike
- Pgcm — Biotite-muscovite alkali-feldspar granite
- Ya — Aplite
- Ygl_P — Granite of Longs Peak batholith
- Ygl_Px — Intrusion breccia
- Ygl_Pz — Garnet-sillimanite granite
- Ydi — Mafic dikes and plugs
- Ygh — Granite of Hagues Peak
- Yqd — Quartz diorite

MESOPROTEROZOIC AND (OR) PALEOPROTEROZOIC INTRUSIVE ROCKS
- Xp — Pegmatite

PALEOPROTEROZOIC INTRUSIVE ROCKS
- XgdB — Boulder Creek Granodiorite
- Xgd — Granodiorite
- Xg — Biotite monzogranite
- Xtd — Trondhjemite of Thompson Canyon

PALEOPROTEROZOIC METAMORPHIC ROCKS
- Xb — Biotite schist and gneiss
- Xbq — Quartzofeldspathic mica schist
- Xba — Knotted mica schist
- Xbp — Porphyroblastic biotite schist
- Xbf — Biotite gneiss and granitic gneiss, interlayered
- Xbh — Biotite gneiss and hornblende gneiss, interlayered
- Xh — Hornblende gneiss and amphibolite
- Xf — Granitic gneiss
- Xfb — Biotite granofels
- Xfcq — Granitic gneiss, calc-silicate gneiss, and quartzite, interlayered

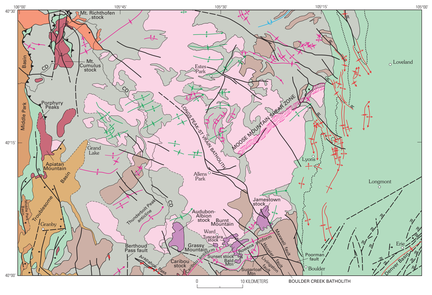
MAP EXPLANATION

- Contact—Dotted where concealed
- Fault, high-angle—Dotted where concealed
- Thrust fault—Dotted where concealed
- Boundary of permanent snowfield (s) or lake shoreline
- Anticline/antiform—Dotted where concealed
- Syncline/synform—Dotted where concealed
- Overturned anticline/antiform—Dotted where concealed
- Overturned syncline/synform—Dotted where concealed
- Monocline—Dotted where concealed
- Vertical fold—Dotted where concealed

Strike and dip of bedding (in bedrock units)
- Inclined
- Inclined—Top direction of beds known from local features
- Vertical
- Overturned
- Overturned—Top direction of beds known from local features
- Area intruded by many small YgLP bodies
- Area intruded by many small YXp bodies
- Area intruded by many small X/T bodies

Strike and dip of foliation
- Inclined flow foliation in igneous rock
- Vertical or near-vertical foliation in igneous rock
- Inclined compaction foliation in welded tuff
- Inclined foliation in metamorphic rock
- Vertical or near-vertical foliation in metamorphic rock
- Inclined foliation in mylonite—Showing bearing and plunge of lineation in mylonite
- Sandstone dike in Proterozoic basement rocks
- Fault breccia zone
- Mylonite-bearing shear zone

Increasing metamorphic grade
- Q — Appearance of garnet
- St — Appearance of staurolite
- And — Appearance of andalusite
- S — Appearance of sillimanite—Disappearance of staurolite
- A — Disappearance of andalusite
- K — Appearance of K feldspar—Disappearance of muscovite
- M — Appearance of partial-melt textures


Mt. Richthofen stock
Mt. Cumulus stock
Loveland
Rocky Mountain Fault
Mummy Range
Mummy Fault
Lumpy Ridge
Estes Park
Longs Peak
Longmont
Apiatan Mountain
Lake Estes
Alluvial Fan
Alluvial Fan
Arapaho Glacier
Jamestown area
Audubon Lake stock
Burns Mountain
Ward
Granby
Granby Pump Fault
Bottleneck Hills fault
Bottleneck Hills fault
Bottleneck Hills