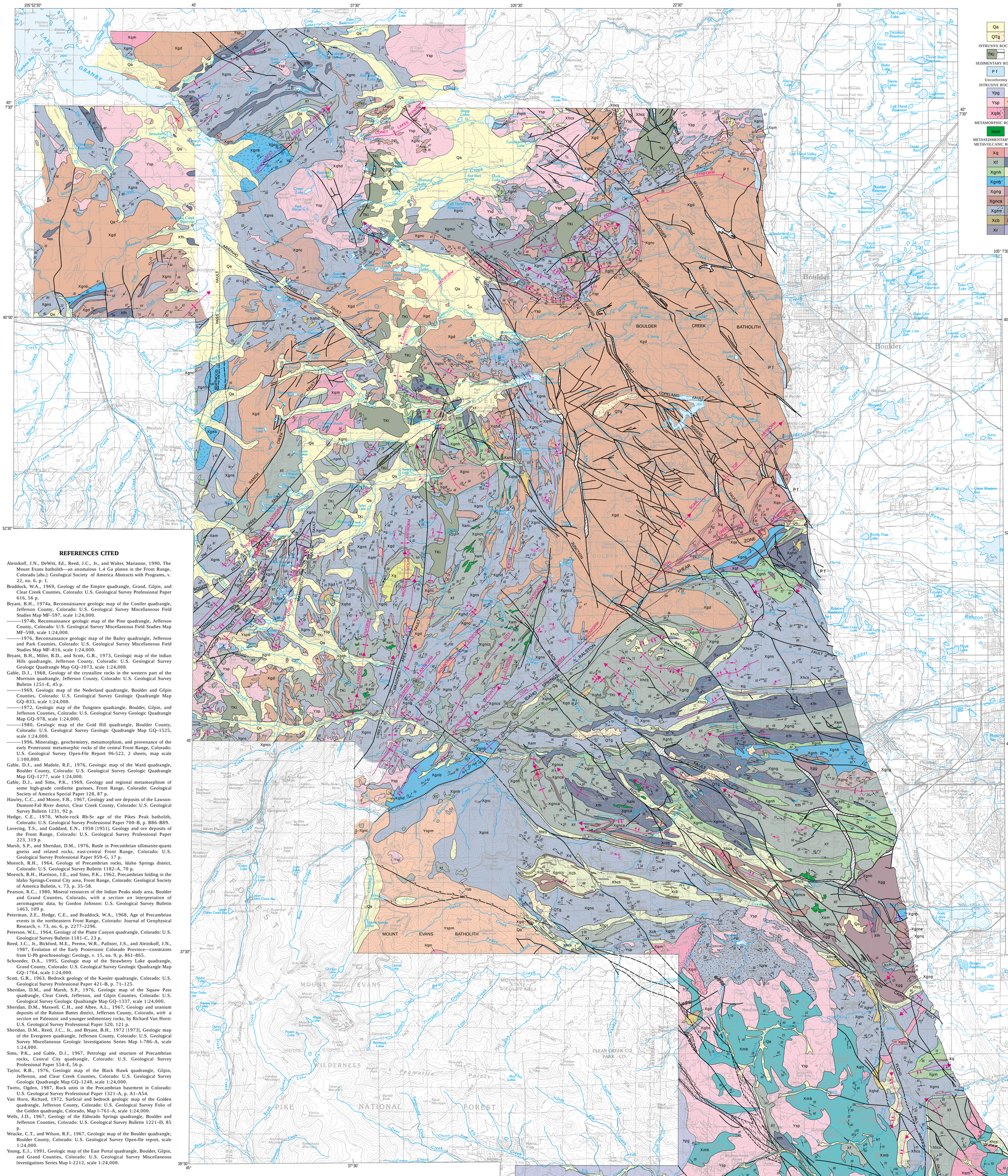
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC INVESTIGATIONS SERIES
I–2605



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Base from U.S. Geological Survey
Bailey, Denver West, 1983; Estes Park, 1984

Universal Transverse Mercator projection
1927 North American datum

APPROXIMATE MEAN DECLINATION, 1999

SCALE 1:100 000

CONTOUR INTERVAL 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

COLORADO
MAP LOCATION

Geology compiled 1976–84
Additions in 1995, with assistance of William D. Johnson, Jr. Map digitized by Springfield and Springfield. Digital cartography by Denny Welp and Gayle Dumonceaux. Edited by F.C. Brunstein.

CONVERSION FACTORS

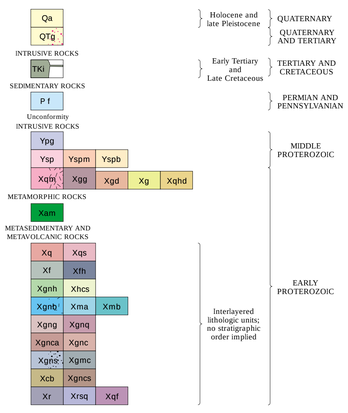
Multiply	By	To obtain
centimeters (cm)	0.3937	inches (in.)
meters (m)	3.281	feet (ft)
kilometers (km)	0.6214	miles (mi)

Printed on recycled paper

GEOLOGIC MAP OF THE PROTEROZOIC ROCKS OF THE CENTRAL FRONT RANGE, COLORADO

Compiled by
Dolores J. Gable
2000

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qa — **Alluvium, colluvium, and glacial deposits (Holocene and late Pleistocene)**—In northwest part of area (Strawberry Lake quadrangle), locally includes Troublesome Formation (Miocene and Oligocene) adjacent to Proterozoic rock units

QTg — **Gravels (Quaternary and Tertiary)**—Rounded to subangular pebbles, and boulders derived from metamorphic and igneous rocks mostly to the west of the map area. Patterned areas consists of debris derived almost entirely from Precambrian rocks and found on higher slopes above modern drainage channels

EARLY TERTIARY AND LATE CRETACEOUS INTRUSIVE ROCKS

TKi — **Monzonite, granodiorite, and syenite**—May include minor amounts of mafic rocks, such as pyroxenite

SEDIMENTARY ROCKS

P f — **Fountain Formation (Permian and Pennsylvanian)**—Map unit locally includes Lykins Formation (Triassic and Permian) and Lyons Sandstone (Permian). Fountain Formation, predominantly arkosic conglomerate and moderately coarse grained sandstone; Lykins Formation, red and light-green calcareous sandstone; Lyons Sandstone, red and pink fine-grained to very fine grained sandstone

PROTEROZOIC INTRUSIVE ROCKS

Ypg — **Pikes Peak Granite (Middle Proterozoic)**—Biotite granite and biotite-hornblende granite, minor quartz syenite, fayalite granite, riebeckite granite, and locally granodiorite and quartz monzonite. Rb-Sr age about 1,040 m.y. (Hedge, 1970)

Silver Plume Granite (or Quartz Monzonite) of the Berthoud Plutonic Suite (Middle Proterozoic)

Ysp — **Quartz monzonite and monzogranite**—Mostly massive, gray to buff, fine- to medium-grained quartz monzonite or monzogranite displaying aligned tabular feldspar crystals and aligned biotite laths, especially along borders of plutons. U-Pb zircon age 1,400 m.y. (Aleinikoff and others, 1990)

Yspm — **Monzodiorite to granodiorite facies**—Medium- to coarse-grained, grayish-white and black, foliated monzodiorite to granodiorite. Exists locally in Mount Evans batholith. Contains 6–8 percent magnetite. U-Pb zircon age of 1,443 m.y. (Aleinikoff and others, 1990)

Yspb — **Inclusions**—Profuse inclusions mostly of biotite gneiss in Silver Plume Granite

Xqm — **Quartz Monzonite (Early Proterozoic)**—Light gray to light tan, leucocratic, and fine to medium grained. Includes Twin Spruce Quartz Monzonite of the Eldorado Springs area. Field evidence suggests Twin Spruce is both younger and the same age as the Boulder Creek Granodiorite. Patterned where unit contains numerous biotite gneiss inclusions

Xgg — **Granodiorite (Early Proterozoic)**—Gray to pinkish-gray, medium- to coarse-grained gneissic granodiorite; weathers darker pinkish gray. Exists locally at Mt. Morrison and in Clear Creek and Turkey Creek canyons. Isotopically fits the 1,700 m.y. isochron of the Boulder Creek Granodiorite (C.E. Hedge, oral commun., 1976)

Xgd — **Boulder Creek Granodiorite and associated rocks of the Routt Plutonic Suite (Early Proterozoic)**—Mottled grayish-white and black, medium- to very coarse grained, locally porphyritic, predominantly granodiorite but includes lenses and layers of gabbro, hornblende diorite, hornblendite, and quartz diorite. Rb-Sr determinations suggest the Boulder Creek is about 1,700 m.y. old (Peterman and others, 1968; Reed and others, 1987)

Xg — **Gabbro and related rocks (Early Proterozoic)**—Dark-gray to pinkish-gray, black and white, massive, coarse-grained to very coarse grained rock ranging in composition from metagabbro to quartz diorite; contains intermediate plagioclase and orthopyroxene and clinopyroxene

Xqhd — **Hornblende diorite, quartz-bearing hornblende diorite, quartz diorite, and hornblendite (Early Proterozoic)**—Gray to black, medium- to fine-grained, gray to black hornblende-bearing rocks. Exists in small plutons, lenses, pods, and dikes

EARLY PROTEROZOIC METAMORPHIC ROCKS

[The mineralogy and modal, chemical, and quantitative analyses of the metamorphic rocks are given in Gable (1996).]

Xam — **Amphibolite**—Dark-greenish-gray to black, fine- to medium-grained, nonlayered to poorly layered, weakly to strongly foliated rock, composed mostly of hornblende and plagioclase

EARLY PROTEROZOIC METASEDIMENTARY AND METAVOLCANIC ROCKS

Xq — **Quartzite and quartz gneiss**—Quartzite is white, gray, and pinkish or purplish gray, medium to coarse grained, and locally conglomeratic. Interlayered with quartz-mica schist and some calc-silicate gneiss lenses. Quartzite along Coal Creek and in Eldorado Springs area is interlayered with conglomeratic quartzite. At some localities, foliated quartz gneiss is conspicuously layered and contains variable amounts of garnet, magnetite-ilmenite, and epidote

Xqs — **Quartz-biotite-muscovite schist**—Silver-gray to dark-gray, fine- to medium-grained, micaceous schist; locally contains porphyroblasts of andalusite, cordierite, and garnet and small amounts of staurolite and sillimanite. Mapped along mountain front in Ralston Buttes area

Xf — **Feldspar-rich gneiss**—Light-gray, leucocratic, fine- to medium-grained, microcline-plagioclase-quartz-biotite gneiss. Conspicuously foliated; granitic in appearance. Locally garnetiferous and ubiquitously interlayered with conformable thin to thick layers and lenses of hornblende gneiss, amphibolite, biotite gneiss, and locally calc-silicate rock

Xfh — **Interlayered feldspar-rich gneiss and hornblende gneiss**—Feldspar-rich gneiss may contain hornblende and is generally darker than the feldspar-rich gneiss unit (Xf). Interlayered hornblende gneiss is black, white, and dark gray or greenish gray and similar in composition to the hornblende gneiss in hornblende gneiss unit (Xgh). Layers and lenses of biotite gneiss, amphibolite, calc-silicate rock, and biotite-quartz-plagioclase gneiss make up 10–30 percent of unit

Xgnh — **Hornblende gneiss and amphibolite**—Black, black and white, and dark gray or greenish gray, fine to medium grained, and layered; has weak to strong foliation. Consists of hornblende-plagioclase-quartz gneiss or hornblende-clinopyroxene-quartz-feldspar gneiss; in places interlayered with amphibolite, calc-silicate gneiss, biotite-quartz-plagioclase gneiss, and minor quartzite

Xhcs — **Interlayered hornblende gneiss, calc-silicate gneiss, and amphibolite**—Black and white, light gray, greenish gray, and yellowish green, fine to medium grained, layered; has moderate to good compositional layering and moderate to weak foliation. More leucocratic than hornblende gneiss (Xgnh) because individual gneiss layers are thicker and contain more felsic, calcic, and quartz-bearing layers. Contains minor cordierite-biotite gneiss and biotite-quartz-plagioclase gneiss

Xgnb — **Biotite gneiss**—Dark-gray, fine- to medium-grained, foliated, biotite-quartz-plagioclase gneiss; locally garnetiferous and microcline-bearing, and interlayered with hornblende gneiss, calc-silicate gneiss, and sillimanite-biotite-quartz gneiss. Patterned areas contain profuse lenses and layers of granite gneiss

Xma — **Biotite gneiss and amphibolite**—Gray, fine- to medium-grained biotite-quartz-plagioclase gneiss interlayered and intergraded; includes profuse thin lenses and layers of amphibolite. Locally contains lenses and layers of hornblende-biotite-plagioclase gneiss, calc-silicate gneiss, quartzite, and profuse lenses and layers of granite gneiss and pegmatite

Xmb — **Biotite-plagioclase gneiss**—Interlayered and intergraded biotite-quartz-plagioclase gneiss and sillimanite-biotite-quartz-plagioclase gneiss; has profuse lenses and layers of granitic gneiss and pegmatite, and at some localities contains small lenses and layers of calc-silicate gneiss, amphibolite, and quartzite. Contains much less amphibole than the biotite gneiss and amphibolite unit (Xma)

Xgng — **Garnet-biotite gneiss**—Exists as individual layers that grade into and are interlayered with minor units of biotite-quartz-plagioclase gneiss, garnet-sillimanite-biotite gneiss, and cordierite-garnet-sillimanite-biotite gneiss

Xgnq — **Quartz-plagioclase gneiss**—Leucocratic, poorly foliated, and contains thin layers of biotite gneiss, feldspar-rich gneiss, quartzite, hornblende gneiss, and amphibolite. Only mapped along mountain front south of Morrison

Xgnca — **Cordierite-garnet-gedrite-biotite gneiss**—Dark gray to black, medium to very coarse grained, foliated to massive. Interlayered with thinner layers of cordierite-biotite gneiss, garnet-biotite gneiss, and cordierite-garnet-sillimanite-biotite gneiss. K-feldspar is not present or is rare in these rocks

Xgnc — **Cordierite-garnet-sillimanite-biotite gneiss ± K-feldspar ± plagioclase**—Generally gray to very dark gray, fine to medium grained, and foliated. Foliation or layering disrupted by pegmatite, garnet, fibrolitic sillimanite, and clusters of cordierite and biotite. May be finely interlayered with one or more of the following types of gneiss: garnet-sillimanite-biotite, cordierite-biotite, garnet-biotite, cordierite-garnet-biotite, cordierite-sillimanite-biotite, magnetite-sillimanite-biotite, and cordierite-magnetite-sillimanite-biotite

Xgns — **Sillimanite-biotite gneiss**—Banded light gray, very dark gray, or black; at some localities interlayered with biotite-quartz-plagioclase gneiss and layers and lenses of amphibolite, biotite gneiss, calc-silicate gneiss, and garnet-biotite gneiss. South of the Idaho Springs-Ralston shear zone, primary muscovite and trace amounts of cordierite present in unit. Pattern shows area that contains profuse pods and lenses of Silver Plume Granite (Ysp)

Xgmc — **Cordierite-magnetite-sillimanite-biotite gneiss and minor magnetite-sillimanite-biotite gneiss**—Light gray to nearly black, fine to medium grained, compositionally layered. In places layers discontinuous due to stringers and clots of pegmatite and knots of cordierite, sillimanite, biotite, and magnetite. Both rock types gradational into cordierite-garnet-sillimanite-biotite gneiss (Xgnc) and sillimanite-biotite gneiss (Xgns)

Xcb — **Cordierite-sillimanite-biotite gneiss**—Light-gray, medium-grained, foliated biotite gneiss. Mapped only in Evergreen-Squaw Pass area

Xgncs — **Calc-silicate gneiss**—Variable gray, green, white, or black and fine to coarse grained. Color depends on the type and quantity of minerals present, such as hornblende, diopside, biotite, calcic-plagioclase, scapolite, and quartz. Foliation poor but compositional layering good

Xr — **Rutile-bearing, sillimanite-quartz gneiss and biotite-quartz gneiss**—Light gray, fine to medium grained, and commonly interlayered with biotite-quartz gneiss and sillimanite-quartz gneiss. Exists as thin lenses in the Evergreen-Squaw Pass area

Xrsq — **Sillimanite-quartz gneiss containing accessory rutile lenses**—Light gray to gray, fine to medium grained, and foliated. Exists only as thin lenses 15 cm to 30 m wide in the Evergreen and Squaw Pass quadrangles; most are of limited extent but one is 6 km long

Xqf — **Augen gneiss**—Fine-grained, sheared gneiss containing small, pink feldspar augen in a well-foliated biotitic matrix. Mapped only in Ralston Buttes area

Contact—Approximately located, dotted where concealed; queried where inferred

Fault or fracture zone—Dashed where approximately located; dotted where concealed; queried where uncertain. Arrows show apparent direction of relative movement. Pattern indicates broad zone of brecciation

Fault zone—Shown where map unit is fractured and not identifiable

Zone of closely spaced shears

Boundary of Idaho Springs-Ralston shear zone

Folds—Showing approximate trace of axial plane and direction of plunge. Dotted where concealed; queried where inferred

Antiform

Overturned antiform

Synform

Overturned synform

Small-scale linear and planar features

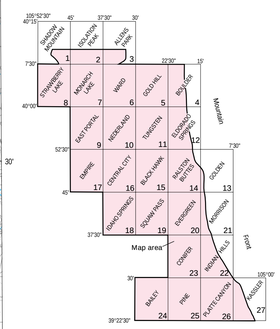
Bearing and plunge of axis of minor folds—Symbols show plan view of minor folds

Strike and dip of foliation

Inclined

Vertical

Bearing and plunge of lineation—Lineations defined by aligned minerals, mineral streaks, and fold axes or intersection of planar elements. Symbol may be combined with foliation symbol



SOURCES OF GEOLOGIC DATA

1. Pearson (1980)
2. Pearson (1980)
3. Pearson (1980)
4. Wrucke and Wilson (1967)
5. Gable (1980)
6. Gable and Madole (1976)
7. Pearson (1980)
8. Schroeder (1995)
9. Young (1991)
10. Gable (1969)
11. Gable (1972)
12. Wells (1967)
13. Van Horn (1972)
14. Sheridan and others (1967)
15. Taylor (1976)
16. Sims and Gable (1967)
17. Braddock (1969)
18. Moench and others (1962) Moench (1964) Hawley and Moore (1967)
19. Sheridan and Marsh (1976)
20. Sheridan and others (1972)
21. Gable (1968)
22. Bryant and others (1973)
23. Bryant (1974a)
24. Bryant (1976)
25. Bryant (1974b)
26. Peterson (1964)
27. Scott (1963)

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