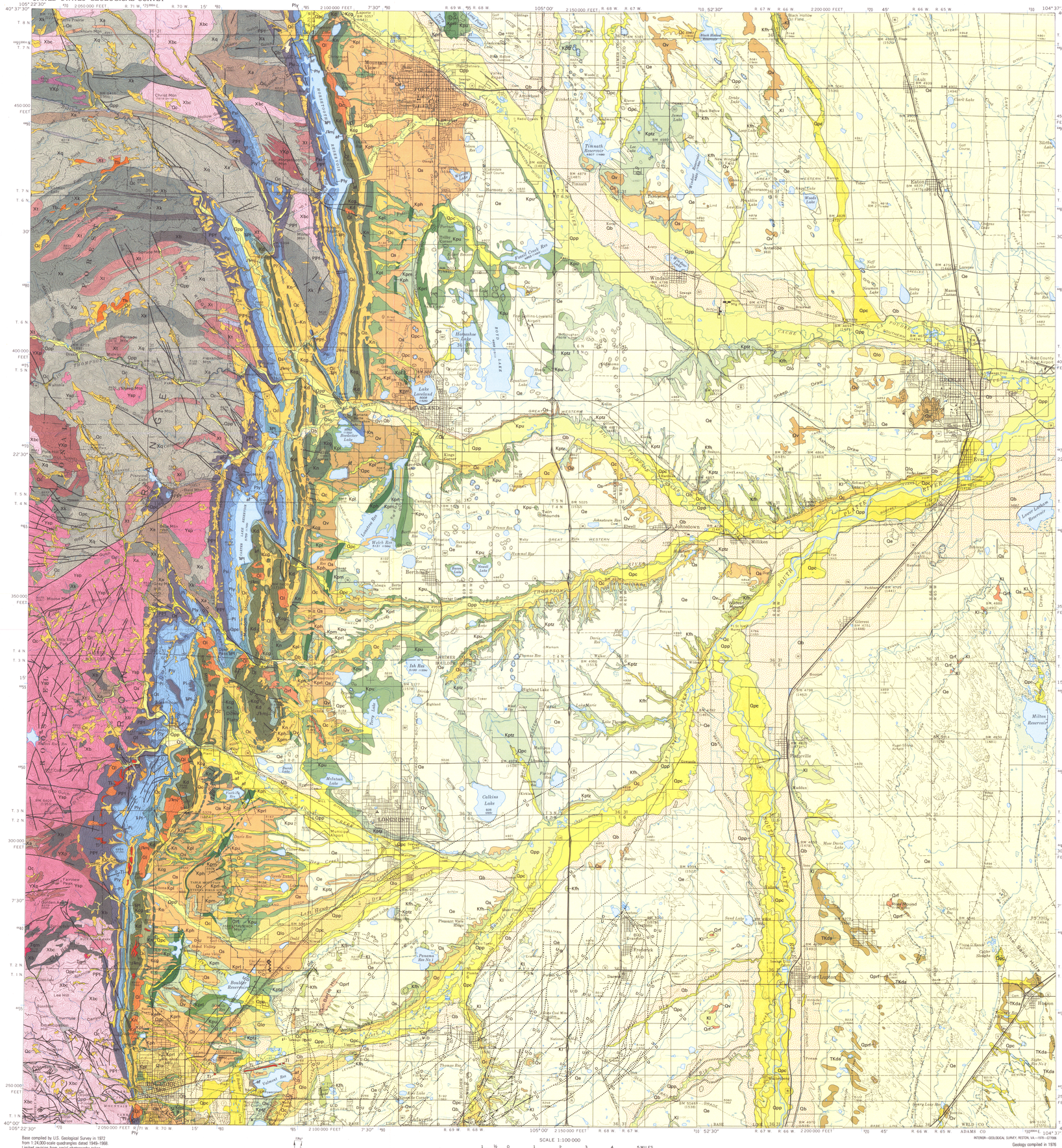
MISCELLANEOUS INVESTIGATIONS SERIES
BOULDER—FORT COLLINS—GREELEY AREA, COLORADO
MAP I-855-G

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY



GEOLOGIC MAP OF THE BOULDER—FORT COLLINS—GREELEY AREA, COLORADO

By
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1978

CORRELATION OF MAP UNITS

af				
Qpp	Holocene	Upper Holocene	Qc, Qe, Qt, Ql	QUATERNARY
Unconformity				
Qpc		Pinedale Glaciation		
Unconformity				
Qlo		Bull Lake Glaciation		
Unconformity				
Qs	Pleistocene	Sangamon Interglaciation or Illinoian Glaciation		
Unconformity				
Qv		Yarmouth Interglaciation or Kansan Glaciation		
Unconformity				
Qpf		Aftonian Interglaciation or Nebraskan Glaciation		
Unconformity				
Qpnf		Nebraskan(?) Glaciation		
Unconformity				
Tb	Pliocene?			
Tqm	Eocene			TERTIARY
Tl	Paleocene			
Unconformity				
TKda	Upper Cretaceous			CRETACEOUS
Kl				
Kfh				
Kpt, Kpu, Kpf, Kpm, Kp				
Kcl				
Kpl				
Kn	Lower Cretaceous			
Unconformity				
Kcg				
Kd				
Unconformity				
J'Jmj				JURASSIC AND TRIASSIC
Unconformity				
TrPl				TRIASSIC AND PERMIAN
Ply				PERMIAN
Psl, Pl, PPf				PENNSYLVANIAN
Unconformity				
Ysp	1.45 b. y.	Precambrian Y		PRECAMBRIAN
YXp, Xbc, Xt, Xq, Xk, Xb, Xa	1.7 b. y.	Precambrian X		

DESCRIPTION OF MAP UNITS

af ARTIFICIAL FILL—Only large rock and earth fills shown

Qpp POST-PINEY CREEK ALLUVIUM (UPPER HOLOCENE)—Dark-gray humic, sandy to gravelly alluvium containing scattered plant remains. Underlies flood plains of major streams and terraces less than 10 feet (3 m) above stream level. Underlain by older alluvial gravel in large valleys. Thickness is from 5 to 15 feet (2 to 5 m). Occasional floods may cover this unit

Qt TALUS (UPPER HOLOCENE TO PLEISTOCENE)—Deposits of slide-rock at the bases of cliffs. Locally as much as 30 feet (9 m) thick; blocks range in size from a few inches across to several feet.

Qc COLLUVIUM (UPPER HOLOCENE TO PLEISTOCENE)—Bouldery to pebbly sandy silt and clay deposited by gravity and sheet wash on slopes. Color and texture of colluvium reflects parent material. May contain and interfinger with alluvium of various ages. Thickness as much as 25 feet (7.5 m) but generally not more than 5 feet (1.5 m); may contain windblown sand and silt. Soil well to poorly developed

Qe EOLIUM* (WINDBLOWN CLAY, SILT (LOESS), SAND, AND GRANULES) (UPPER HOLOCENE TO BULL LAKE GLACIATION)—Light-brown to reddish-brown to olive-gray deposits of windblown clay, silt, sand, and granules mainly as sand dunes in the east half of the area but also as a blanket of loess between the Front Range and the South Platte River. Loess is as much as 15 feet (4.5 m) thick but generally is less than 3 feet (1 m) thick; sand dunes are as much as 50 feet (15 m) thick but generally are less than 15 feet (4.5 m) thick
*New term introduced here to include deposits of windblown silt (loess) and wind-drifted sand (dunes) granules, and pebbles and gradations between

Ql LANDSLIDE DEPOSITS (HOLOCENE TO PLEISTOCENE)—Slumps, rock falls, and earthflows that range from active to inactive. Material in the deposits ranges in size from clay and silt to blocks several feet in diameter (near outcrops of the Fountain Formation and Dakota Group)

Qpc PINEY CREEK ALLUVIUM (LYPER HOLOCENE)—Dark-gray humic sandy to gravelly alluvium containing organic matter, such as roots. Underlies terraces whose surfaces are 10 to 20 feet (3 to 6 m) above a nearby flood plain. Upper part is characterized by weakly developed Brown soil; grades into colluvium upslope. Areas underlain by this formation are not usually covered by floodwaters, but areas along the South Platte River were partly covered in 1965 and again in 1973. Thickness is 0–6 m (0–20 ft). Locally includes some post-Piney Creek alluvium

Qb BROADWAY ALLUVIUM (PINEDALE GLACIATION, PLEISTOCENE)—Sand and gravel deposited by the South Platte River and its tributaries. Well-sorted and well-stratified; size analyses indicate that the average size distribution is 50% sand, 25% granules and 25% pebbles. Poorly developed Brown soil profile of early Holocene age underlies surface of deposit. Terrace surfaces are about 40 feet (13 m) above major streams near the Front Range but are only 20 ft (6 m) above near Greeley. Locally, map unit includes some gravel of Louviers age. Along tributaries the Broadway Alluvium is 10 to 15 ft (3 to 5 m) thick. Thickness of Broadway and Louviers Alluviums along South Platte River is as much as 125 ft (38 m), but averages only 35 ft (11 m)

Qlo LOUVIERS ALLUVIUM (BULL LAKE GLACIATION, PLEISTOCENE)—Reddish-brown pebbly to bouldery well stratified alluvium along perennial streams and sandy to clayey alluvium along intermittent streams. Well developed Brown soil profile underlies surface of deposit. Terrace surface is 70 feet (21.5 m) above major streams near mountains but deposit is buried under Broadway Alluvium along South Platte River

Qs SLOCUM ALLUVIUM (SANGAMON INTERGLACIATION OR ILLINOIAN GLACIATION, PLEISTOCENE)—Brown to white cobble and boulder gravel as much as 20 feet (6 m) thick. Most clasts are well-rounded igneous and metamorphic rocks; some are sedimentary; most are weathered and have thin rinds of calcium carbonate. Well-developed soil profile consists of a thin A horizon, 6 to 12 inches (15 to 30 cm) thick; a clayey, reddish brown B horizon, 2 feet (0.6 m) thick, and a Cca or calche horizon, 3 feet (1 m) thick. Upper surface of deposits is generally 100 to 130 feet (30 to 40 m) above major streams—less in northeast corner of area

Qv VERDOS ALLUVIUM (YARMOUTH INTERGLACIATION OR KANSAN GLACIATION, PLEISTOCENE)—Brown sand and gravel (in part boulder gravel). Pebbles, cobbles, and boulders are weathered and partly decomposed. Upper 2 to 3 feet consists of fine- to coarse-grained flood-plain and eolian deposits; well-developed Brown soil profile. At most localities, upper part of soil profile has been truncated and Cca (calcium carbonate enriched or calche) horizon is near the surface. Calche fills interstices and coats all stones, especially their undersides. Veinlets of calche extend downward to a depth of 4 feet. Most clasts are coated by a thick rind of calcium carbonate; locally, gravel is cemented by calche. Most stones are granite, gneiss, or schist; some are quartzite, sandstone, and limestone. Deposits are as much as 20 feet (6 m) thick but generally are between 10 and 15 feet (3 and 4.5 m) thick. Upper surfaces of deposits are generally 200 to 250 feet (60 to 75 m) above major streams but are less in northeast part of area

Qrf ROCKY FLATS ALLUVIUM (AFTONIAN INTERGLACIATION OR NEBRASKAN GLACIATION, PLEISTOCENE)—Brown to white, coarse, poorly sorted, poorly to well-stratified gravel. Maximum diameter of clasts is about 2 feet (0.3 m). Clasts mostly of rounded granite, granodiorite, tonalite, gneiss, schist, and quartzite; subordinate sandstone and limestone. Deposit is as much as 10 ft (3 m) thick but generally less. Soil profiles have been truncated, and only a thick calche remains. Upper surface of deposits is generally about 325 feet (100 m) above local major streams near mountains but is only about 230 ft (73 m) above streams in northeast part of area

Qpf PRE-ROCKY FLATS ALLUVIUM (NEBRASKAN?) GLACIATION, PLEISTOCENE)—Brown to white cemented gravel and sand 3 to 6 ft (1 to 2 m) thick capping Gunbarrel Hill. Approximately 38% of the clasts are sandstone, 37% are pegmatite, 7% are quartzite, 5% are shoshonite, 8% are gneiss and 5% are amphibolite. Size analyses indicate that 44% is sand, 8% granules, and 48% pebbles and cobbles. The maximum diameter of clasts is about 5 inches. Soil profile is truncated and only caliche remains; weathered pegmatite and biottic clasts crumble. Upper surfaces of gravel deposits are 330 to 380 ft (103 to 115 m) above local major streams

Tb BOULDER DEPOSITS (PLIOCENE?)—Boulder and cobble gravel deposits composed mostly of weathered clasts of pegmatite and tonalite. Thickness unknown but might be as much as 30 feet (10 m)

Tqm QUARTZ MONZONITE (EOCENE)—Fine- to medium-grained, biotite-hornblende quartz monzonite; small irregular intrusive bodies and stocks. Radiometric age (Marvin, Young, Mehnert and Naeser, 1974, p. 11 (no. 69)) is 45.4±1 m.y. or 50.6±7.1 m.y.

Tr RHYODACITE AND BASALT (PALEOCENE)—Rhyodacites in sills between Lyons and Boulder are light-gray, very fine grained felsite and felsite porphyry; contain phenocrysts as much as 5 mm in diameter. Sills are as much as 150 feet (46 m) thick, but most are about half that. Radiometric age (Larson and Hoblitt, 1973, p. 3) of Flagstaff Mountain sill is 64.6–2.6 million years. The Valmont dike (east of Boulder) is thought to be a medium-grained holocrystalline basalt, basaltic andesite, mafic latite, or alkalic basalt (according to Larson and Hoblitt, 1973) or shoshonite (according to Trimble, 1975). The dike is 20 to 40 feet (6 to 12 m) wide and nearly vertical; magnetic surveys indicate it is about 5 miles (8 km) long

TKda DENVER (PALEOCENE AND UPPER CRETACEOUS) AND ARAPAHOE (UPPER CRETACEOUS) FORMATIONS—Olive-gray claystone and siltstone interbedded with tuffaceous sandstone and conglomerate. Weathered sandstone and conglomerate contain montmorillonite and related expandable clay minerals. Thickness at least 565 feet (170 m)

Kl LARAMIE FORMATION (UPPER CRETACEOUS)—Upper part, 600 to 700 feet (185 to 210 m) thick, is mostly gray claystone, shale, sandy shale, and scattered lenticular beds of sandstone and lignite. Lower part, about 80 to 125 feet (25 to 38 m) thick, is light-gray to light yellowish-gray sandstone and sandy shale interbedded with clay, shale, and several beds of coal

Kfh FOX HILLS SANDSTONE (UPPER CRETACEOUS)—Upper part of formation consists of crossbedded tan sandstone. Grades downward into brown, fine-grained silty sandstone interbedded with gray fissile shale. Locally it may contain a thin coal bed. Thickness about 300 feet (92 m) to 500 feet (152 m)

Kp PIERRE SHALE, UNDIFFERENTIATED (UPPER CRETACEOUS)—This formation has been subdivided into the following members on the basis of lithology and stratigraphic position: (adapted from Scott and Cobban, 1965)

Kpt Upper transition member—Friable sandstone, soft shaly sandstone containing thin-bedded sandy shale and large calcareous sandstone concretions. The member is about 2,000 ft (620 m) thick

Kpu Upper shale member—Gray concretionary silty shale. Thickness about 2,800 ft (865 m)

Kprl Richard Sandstone Member, unnamed shale member, Larimer Sandstone Member, unnamed shale member, and Rocky Ridge Sandstone Member. Sandstones of these members pinch out in eastern and southern part area. Richard Sandstone Member consists of pale-brown dusey micaceous siltstone and sandstone; the Larimer Sandstone Member is a hard to soft yellowish-brown sandstone; the Rocky Ridge Sandstone Member is a light-brown fine- to medium-grained glauconitic sandstone. Thickness of unit varies from 230 ft (71 m) to 530 ft (161 m)

Kpm Middle shale member—Claystone and sandy siltstone; about 1,460 ft (450 m) thick. Map unit includes Terry Sandstone Member (not mapped) near middle; about 60 ft (18.5 m) thick

Kph Hygiene Sandstone Member—An upper hard glauconitic ridge-forming sandstone separated from a lower friable sandstone by a shale. Member is 600 to 800 ft (185 to 242 m) thick. Pinches out in eastern and thins in southern part of area

Kpl Lower shale member—Consists of Motten Black Shale Member, Sharon Springs Member, and Common Fernglauca Member; these three members are mostly dark olive-gray bentonitic shale. Thickness about 1,220 to 1,650 ft (500 m)

Kn NIOBRARA FORMATION (UPPER CRETACEOUS)—Total thickness about 380 ft (115 m) at Boulder, 255 ft (79 m) near Ft. Collins, and 405 ft (124 m) near Greeley. Consists of two members
Smoky Hill Shale Member—Grayish-orange to grayish-yellow chalky shale and chalky limestone. About 360 ft (110 m) thick near Boulder and 230 ft (70 m) thick near Ft. Collins
Fort Hays Limestone Member—Gray hard thickbedded fossiliferous limestone containing thin silty shale and bentonite layers near the middle. About 20 to 35 ft (6 to 11 m) thick

Kcg CARLILE SHALE, GREENHORN LIMESTONE AND GRANEROS SHALE —Total thickness 450 to 495 ft (140 to 150 m) in the Boulder area, 510 ft (165 m) in the Ft. Collins area, 540 ft (180 m) near Loveland, and 353 ft (106 m) near Milliken
Carlile Shale (Upper Cretaceous)—Olive-gray silty claystone and sandy siltstone; about 75 ft (23 m) thick
Greenhorn Limestone (Upper Cretaceous)—Interlayered dark-gray limestone and olive-gray calcareous silty claystone and siltstone; about 260 ft (80 m) thick
Graneros Shale (Upper and Lower Cretaceous)—Dark-gray to grayish-black siltstone and claystone; about 160 ft (49 m) thick

Kd DAKOTA GROUP (LOWER CRETACEOUS)—Total thickness about 290 ft (88 m) near Ft. Collins, 275 ft (84 m) near Boulder, and 263 ft (81 m) near Milliken. Consists of two formations
South Platte Formation—Light- to dark-gray well-sorted fine-grained cross-stratified and ripple laminated sandstone, siltstone, and gray carbonaceous shale. Thickness about 225 ft (69 m)
Lytle Formation—Yellowish-gray conglomeratic sandstone containing pebbles of chert and quartzite. About 50 ft (16 m) thick

J'Jmj MORRISON, CANYON SPRINGS MEMBER OF SUNDANCE AND JELM FORMATIONS
Morrison Formation (Upper Jurassic)—Upper part of Morrison Formation is brown sandy marly shale underlain by red and gray shale with thin beds of silty limestone. Lower part is fine- to medium-grained sandstone 10 to 15 ft (3 to 4.5 m) thick underlain by dark-greenish-gray impure limestone and marlstone beds and interbedded with marly shales. Thickness and lithology vartable but in the Lyons area is about 250 to 300 ft (77 to 92 m) thick and consists of 60% shale, 25% limestone and marl, and 15% sandstone
Canyon Springs Member of Sundance Formation (Upper Jurassic)—Light-pink to grayish-white, crossbedded, fine-grained, well sorted sandstone; about 30 feet (9 m) thick at Boulder and Lyons but only 15 feet (4.5 m) thick near Ft. Collins
Jelm Formation (Upper Trlassic)—Pinkish-gray, conspicuously jointed crossbedded fine- to medium-grained sandstone; about 20 feet (6 m) thick near Lefthand Creek, 60 feet (18 m) thick near Lyons, 95 feet (29 m) thick near Boulder, 132 feet (40 m) thick near Masonville, and 115 feet (35 m) thick near Greeley

TrPl LYKINS FORMATION (TRIASSIC AND PERMIAN)—Total thickness about 675 feet (205 m). Consists of following members:
Strain Shale Member of LeRoy (1946)—Maroon or reddish-brown shale and siltstone. Thickness 490 feet (150 m) at Boulder and 300 feet (92 m) at Masonville
Fordlle Limestone Member—Yellowish-brown and yellowish-gray finely laminated wavy folded limestone 8 to 16 feet (2.4 to 5 m) thick
Bergen Shale, Falcon Limestone, and Harriman Shale Members of LeRoy (1946)—Moderate reddish-brown thin-bedded silty shale (predominant) and limestone (subordinate) about 150 feet (46 m) thick

Ply LYONS SANDSTONE (PERMIAN)—Moderate orange to pink to pinkish-gray, fine- to medium-grained, firmly cemented, well-sorted, cross-stratified, quartzose sandstone; about 250 feet (77 m) thick in the Boulder area, 325 feet (108 m) in the Lyons quadrangle, but only 20 feet (6 m) thick northwest of Ft. Collins; at Greeley it is about 100 feet (31 m) thick

Psl SATANKA AND INGLESIDE FORMATIONS (PERMIAN)—Mapped together north of Little Thompson River
Satanka Formation—Red siltstone and fine-grained thin-bedded ripple-laminated sandstone. About 225 feet (69 m) thick near Masonville; 242 feet (67 m) thick near Milliken but thins southward along the Front Range and pinches out near the canyon of the Little Thompson River
Ingleside Formation—Red calcareous fine- to medium-grained well-sorted crossbedded sandstone. Thickness about 115 feet (35 m) near Masonville; thins southward and pinches out a few miles south of Lyons

Pi INGLESIDE FORMATION—Mapped separately south of Little Thompson River

PPf FOUNTAIN FORMATION (PERMIAN AND PENNSYLVANIAN)—Moderate reddish-brown, iron oxide stained, interstratified arkosic conglomerate and moderately coarse-grained, feldspathic sandstone containing thin layers of dark reddish-brown to purplish-red shale; thickness varies from 700 to 1,600 feet (210 to 480 m). Measured section near Lyons consists of 53% sandstone, 37% siltstone, 10% conglomerate, and a few thin gray beds of limestone

Ysp SILVER PLUME QUARTZ MONZONITE (PRECAMBRIAN Y)—Pale yellowish-orange to pale reddish-gray, equigranular, fine- to medium-grained, biotite-muscovite-quartz monzonite; some outcrops are gray to tan, medium- to coarse-grained porphyritic quartz monzonite that contains tabular microcline phenocrysts; commonly shows trachytoid flow structure. Composed of microcline, plagioclase, quartz, and subordinate biotite and muscovite

YXp PEGMATITE (PRECAMBRIAN Y OR X)—Coarse-grained pegmatite which forms concordant to irregular discordant tabular or dike-like bodies that are mostly unzoned. Composed of feldspar, quartz, muscovite, and minor biotite. May be related in age to the Boulder Creek Granodiorite and to the Silver Plume Quartz Monzonite

Xbc BOULDER CREEK GRANODIORITE (PRECAMBRIAN X)—Light- to dark-gray medium- to coarse-grained gneissic granodiorite commonly forming concordant bodies; composed of quartz, calcic oligoclase or andesine, orthoclase, biotite and hornblende

Xt TONALITE (PRECAMBRIAN X)—Light-gray quartz diorite consisting of plagioclase (predominant), quartz, and (subordinate) hornblende or biotite or both. Varies from medium-grained and equigranular to very fine-grained and porphyritic; non-foliated; may be discordant or concordant

METASEDIMENTARY ROCKS (PRECAMBRIAN X)—Mineralogic compositions varies with grade of metamorphism. Muscovite, quartz, plagioclase, and biotite are common; chlorite, tourmaline, garnet, staurolite, andalusite, microcline, and sillimanite may be present

Xq Quartzofeldspathic schist and gneiss interbedded with mica schist and gneiss—Contains thin beds of knotted mica schist and granule to pebble metaconglomerate

Xk Knotted mica schist—Characterized by porphyroblasts of staurolite and andalusite or by knots of sillimanite. Locally contains thin beds of granule to pebble metaconglomerate and quartzofeldspathic schist

Xb Porphyroblastic biotite schist—Characterized by abundant porphyroblasts of coarse biotite

Xa AMPHIBOLITE (PRECAMBRIAN X)—Dark-gray to black, well- to poorly-foliated rock composed of hornblende, quartz, and plagioclase; locally contains layers or pods of calc-silicate gneiss

CONTACT

FAULT OR LINEAR FEATURE INFERRED TO BE A FAULT—Dotted where concealed U, upthrown side; D, downthrown side; crosshatched area is brecciated rock

TERRACE SCARP

DEFLATION BASIN (HOLOCENE TO PLEISTOCENE)—Closed depressions eroded by wind action and, perhaps, by cattle and bison. Floored locally by thin deposits of clay, silt, and sand; elsewhere by bedrock or older surficial deposits

CREST OF DUNE

LEEWARD MARGIN OF MIGRATORY DUNE GROUP

BURIED CHANNELS UNDER BEEBE AND EATON DRAWS

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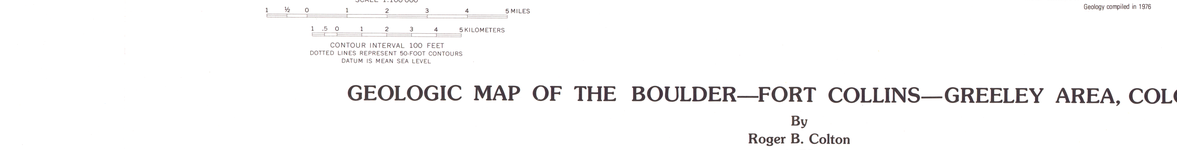

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