DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE GEOLOGICAL SURVEY OF COLORADO

Base from U.S. Geological Survey, 1969
Lambert conformal conic projection based on standard parallels 33° and 45°

SCALE 1:500 000
1 inch equals approximately 8 miles (13 kilometers)
1 centimeter equals approximately 5 kilometers (3 miles)

10 0 10 20 30 40 50 MILES

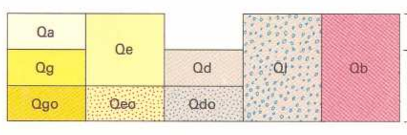
10 0 10 20 30 40 50 KILOMETERS

CONTOUR INTERVAL 500 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1979, REPRINTED 1988, 1992

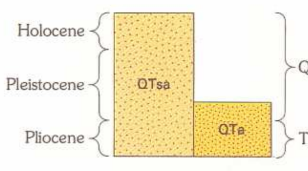
Geologic compilation cartography by R. E. Schoenfeld

E X P L A N A T I O N



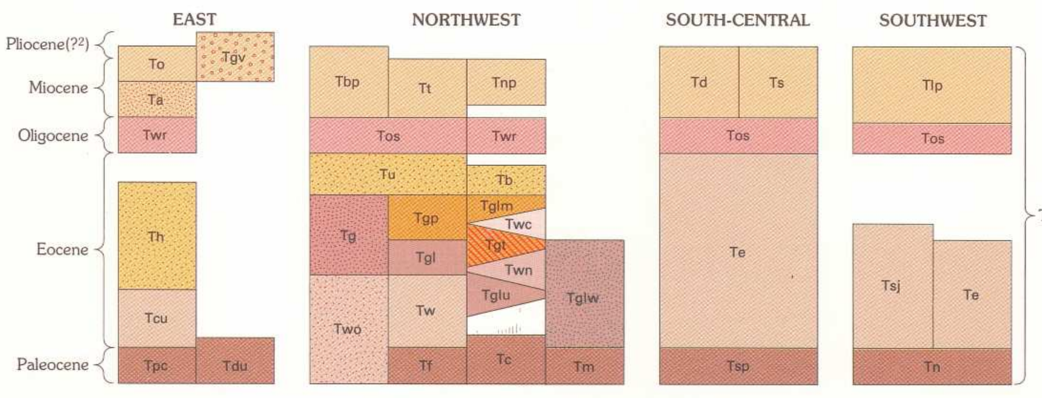
UNCONSOLIDATED SURFICIAL DEPOSITS AND ROCKS OF QUATERNARY AGE

Qa MODERN ALLUVIUM—Includes Piney Creek Alluvium and younger deposits
Qg GRAVELS AND ALLUVIUMS (PINEDALE AND BULL LAKE AGE)—Includes Broadway and Louviers Alluviums
Qgo OLDER GRAVELS AND ALLUVIUMS (PRE-BULL LAKE AGE)—Includes Slocum, Verdos, Rocky Flats, and Nussbaum Alluviums in east, and Florida, Bridgetimber, and Bayfield Gravels in southwest
Qe EOLIAN DEPOSITS—Includes dune sand and silt and Peoria Loess
Qeo OLDER EOLIAN DEPOSITS—Includes Loveland Loess
Qd GLACIAL DRIFT OF PINEDALE AND BULL LAKE GLACIATIONS—Includes some unclassified glacial deposits
Qdo OLDER GLACIAL DRIFT (PRE-BULL LAKE AGE)
Ql LANDSLIDE DEPOSITS—Locally includes talus, rock-glacier, and thick colluvial deposits
Qb BASALT FLOWS (AGE <1.8 M.Y.[1])



UNCONSOLIDATED DEPOSITS OF QUATERNARY AND LATE TERTIARY AGE

QTsa UNCLASSIFIED SURFICIAL DEPOSITS AND UNDERLYING ALAMOSA FORMATION (GRAVEL, SAND, AND SILT) IN SAN LUIS VALLEY
QTa ANCIENT ALLUVIUM—In isolated patches that may not all be of the same age



SEDIMENTARY ROCKS OF TERTIARY AGE

EAST

To OGALLALA FORMATION—Loose to well-cemented sand and gravel
Tgv BOULDERY GRAVEL ON OLD EROSION SURFACES IN FRONT RANGE AND NEVER SUMMER MOUNTAINS
Ta ARIKAREE FORMATION—Sandstone; contains abundant volcanically derived material
Twr WHITE RIVER FORMATION OR GROUP—Ashy claystone and sandstone. Includes Castle Rock Conglomerate in region southeast of Denver
Th HUERFANO FORMATION—Shale and sandstone. Includes Farisita Conglomerate in northwestern Huerfano County
Tcu CUCHARA FORMATION—Sandstone and shale
Tpc POISON CANYON FORMATION—Arkosic conglomerate, sandstone, and shale
Tdu UPPER PART OF DAWSON ARKOSE—Arkosic sandstone, conglomerate, and shale. Includes Green Mountain Conglomerate south of Golden

NORTHWEST

Tbp BROWNS PARK FORMATION—Sandstone and siltstone; west of Park Range
Tt TROUBLESOME FORMATION—Sandstone and siltstone; in Middle Park
Tnp NORTH PARK FORMATION—Sandstone, siltstone, and conglomerate; in North Park and Laramie basin
Tos OLIGOCENE SEDIMENTARY ROCKS—Includes Duchesne River Formation (sandstone and shale; includes some rocks of Eocene age) and Bishop Conglomerate near Utah border
Twr WHITE RIVER FORMATION—Ashy claystone and sandstone; in North Park
Tu UINTA FORMATION—Sandstone and siltstone; in Piceance basin. Formerly Evacuation Creek Member of Green River Formation
Tb BRIDGER FORMATION—Claystone and mudstone; in Sand Wash basin
Tg GREEN RIVER FORMATION—Marlstone, sandstone, and oil shale
Tgp Parachute Creek Member—Oil shale, marlstone, and siltstone; in Piceance basin
Tgl Lower part—Shale, sandstone, marlstone, and limestone in Anvil Points, Garden Gulch, and Douglas Creek Members; in Piceance basin
Tglm Laney Member—Claystone, oil shale, and sandstone; in Sand Wash basin
Tgt Tipton Tongue—Claystone and oil shale; in Sand Wash basin. In extreme northwest includes rocks of Wilkins Peak Member
Tglu Luman Tongue—Carbonaceous shale and marlstone; in Sand Wash basin
Tglw LOWER PART OF GREEN RIVER FORMATION AND WASATCH FORMATION—Shale and sandstone
Tw WASATCH FORMATION—Claystone, shale, and sandstone

NORTHWEST (Continued)

Twc Cathedral Bluffs Tongue—Claystone, mudstone, and sandstone; in Sand Wash basin
Twn Niland Tongue—Mudstone, sandstone, and carbonaceous shale; in Sand Wash basin
Two WASATCH FORMATION (INCLUDING FORT UNION EQUIVALENT AT BASE) AND OHIO CREEK FORMATION—Claystone, mudstone, sandstone, and conglomerate
Tf FORT UNION FORMATION—Shale, sandstone, and local coal beds
Tc COALMONT FORMATION—Arkosic sandstone, conglomerate, and shale; coal in lower part; in North Park
Tm MIDDLE PARK FORMATION EXCLUSIVE OF WINDY GAP MEMBER—Arkosic sandstone and conglomerate containing abundant volcanic materials. Arbitrary line between Middle Park and Coalmont Formations is at Continental Divide

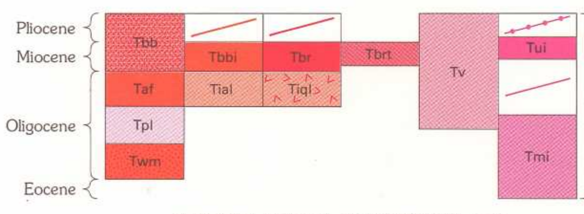
SOUTH-CENTRAL

Td DRY UNION FORMATION—Siltstone, sandstone, and conglomerate. Includes Wagontongue Formation (Miocene) in South Park
Ts SANTA FE FORMATION—Siltstone, sandstone, and conglomerate
Tos OLIGOCENE SEDIMENTARY ROCKS—Includes Florissant Lake Beds (tuffaceous shale and tuff) and Antero Formation (limestone, tuff, tuffaceous sandstone, and conglomerate)
Te EOCENE PREVOLCANIC SEDIMENTARY ROCKS—Arkosic sand and bouldery gravel of Echo Park Alluvium
Tsp SOUTH PARK FORMATION—Arkosic sandstone and shale, volcaniclastic conglomerate, and andesite flows and breccia

SOUTHWEST

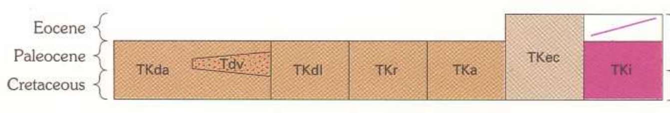
Tlp LOS PINOS FORMATION—Volcaniclastic conglomerate interbedded with basalt flows of Hinsdale Formation (Tbb) on east flank of San Juan Mountains. Grades laterally into Santa Fe Formation of San Luis Valley
Tos OLIGOCENE SEDIMENTARY ROCKS—Includes Creede Formation (tuffaceous siltstone, sandstone, conglomerate) and gravels interbedded with volcanic rocks northeast and southeast of Gunnison
Tsj SAN JOSE FORMATION—Siltstone, shale, and sandstone
Te EOCENE PREVOLCANIC SEDIMENTARY ROCKS—Includes Telluride Conglomerate and Blanco Basin Formation (arkosic mudstone, sandstone, and conglomerate)
Tn NACIMIENTO FORMATION—Shale and sandstone

[1]Million years.
[2]Age of upper parts of uppermost Tertiary units is problematic. These parts have historically been assigned to the Pliocene. Successive reductions in radiometric age of the base of the Pliocene in Europe to 7 m.y. (Lambert, 1971) or 5 m.y. (Berggren, 1972) places a Pliocene age in question, though top beds of the formations have not been dated.



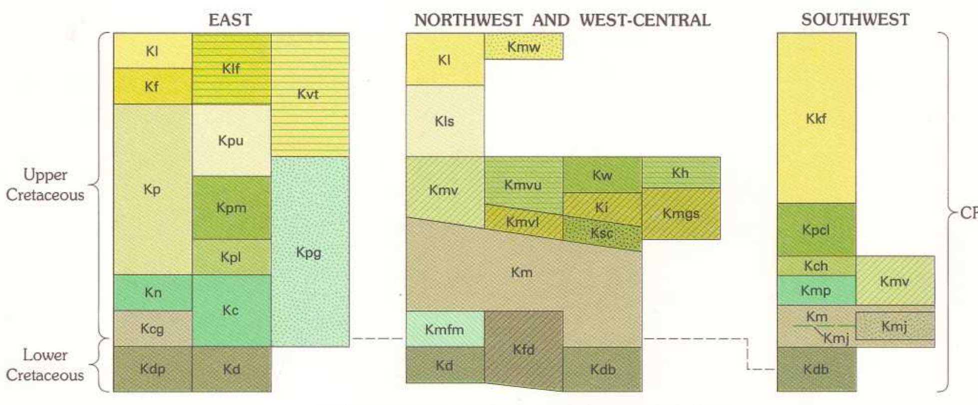
IGNEOUS ROCKS OF TERTIARY AGE

Tbb BASALT FLOWS AND ASSOCIATED TUFF, BRECCIA, AND CONGLOMERATE OF LATE-VOLCANIC BIMODAL SUITE (AGE 3.5–26 M.Y.)—Includes basalts of Hinsdale Formation in San Juan Mountains, Servilleta Formation in San Luis Valley, and many other occurrences
Tbbi BASALTIC INTRUSIVE ROCKS RELATED TO BASALT FLOWS (Tbb)—In dikes and plugs
Tbr RHYOLITIC INTRUSIVE ROCKS AND FLOWS OF LATE-VOLCANIC BIMODAL SUITE
Tbrt ASH-FLOW TUFF OF LATE-VOLCANIC BIMODAL SUITE (AGE 22–23 M.Y.)
Taf ASH-FLOW TUFF OF MAIN VOLCANIC SEQUENCE (AGE IN SAN JUAN MOUNTAINS 26–30 M.Y.; IN SOUTH PARK 29–32 M.Y.)—Includes many named units
Tial INTRA-ASH FLOW ANDESITIC LAVAS
Tiql INTRA-ASH-FLOW QUARTZ LATITIC LAVAS
Tpl PRE-ASH-FLOW ANDESITIC LAVAS, BRECCIAS, TUFFS, AND CONGLOMERATES (GENERAL AGE 30–35 M.Y.)—Includes several named units
Twm WALL MOUNTAIN TUFF (OLDER THAN TUFFS OF SAN JUAN PROVENANCE; AGE 35–36 M.Y.)—Early ash-flow tuff of Sawatch Range provenance
Tv VOLCANIC ROCKS IN NORTHWESTERN COLORADO (AGE <7–33 M.Y.)—Mainly of intermediate compositions
Tui UPPER TERTIARY INTRUSIVE ROCKS (AGE <20 M.Y.)—Intermediate to felsic compositions
Tmi MIDDLE TERTIARY INTRUSIVE ROCKS (AGE 20–40 M.Y.)—Intermediate to felsic compositions



SEDIMENTARY AND IGNEOUS ROCKS OF EARLY TERTIARY AND LATE CRETACEOUS AGE

TKda DENVER AND ARAPAHOE FORMATIONS—Sandstone, mudstone, claystone, and conglomerate; Denver is characterized by andesitic materials
Tdv BASALTIC FLOWS IN DENVER FORMATION NEAR GOLDEN (AGE 62–64 M.Y.)
TKdl DENVER FORMATION OR LOWER PART OF DAWSON ARKOSE—Arkosic sandstone, shale, mudstone, conglomerate, and local coal beds
TKr RATON FORMATION—Arkosic sandstone, siltstone, and shale; contains major coal deposits in Raton Basin
TKa ANIMAS FORMATION—Arkosic sandstone, shale, and conglomerate; contains abundant volcanic materials; Upper Cretaceous volcaniclastic McDermott Member at base
TKec TELLURIDE CONGLOMERATE OF EOCENE PREVOLCANIC SEDIMENTARY ROCKS (Te) AND CIMARRON RIDGE FORMATION (UPPER CRETACEOUS, VOLCANIC BRECCIA AND CONGLOMERATE, AGE ABOUT 66 M.Y.)—In northwestern San Juan Mountains
TKi LARAMIDE INTRUSIVE ROCKS (AGE 40–72? M.Y.)—Mainly intermediate to felsic compositions; some mafic



SEDIMENTARY ROCKS OF CRETACEOUS AGE

EAST

Kl LARAMIE FORMATION—Shale, claystone, sandstone, and major coal beds
Kf FOX HILLS SANDSTONE
Klf LARAMIE FORMATION AND FOX HILLS SANDSTONE
Kvt VERMEJO FORMATION (SHALE, SANDSTONE, AND MAJOR COAL BEDS) AND TRINIDAD SANDSTONE
Kp PIERRE SHALE, UNDIVIDED
Kpu Upper unit
Kpm Middle unit—In Boulder-Fort Collins area, contains Richard, Larimer, Rocky Ridge, Terry, and Hygiene Sandstone Members; elsewhere, shale between zones of *Baculites reesidei* and *B. scotti*
Kpl Lower unit—Sharon Springs Member (organic-rich shale and numerous bentonite beds) in lower part
Kn NIOBRARA FORMATION—Calcareous shale and limestone
Kcg CARLILE SHALE, GREENHORN LIMESTONE, AND GRANEROS SHALE
Kc COLORADO GROUP—Consists of Niobrara Formation (Kn) and either Benton Shale or Carlile, Greenhorn, and Graneros Formations (Kcg)
Kpg PIERRE SHALE (Kp), NIOBRARA (Kn), AND CARLILE, GREENHORN, AND GRANEROS (Kcg) FORMATIONS, UNDIVIDED
Kdp DAKOTA SANDSTONE AND PURGATOIRE FORMATION—Sandstone and shale
Kd DAKOTA SANDSTONE OR GROUP

NORTHWEST AND WEST-CENTRAL

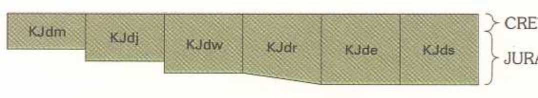
Kl LANCE FORMATION—Shale, sandstone, and minor coal beds; Fox Hills equivalent at base
Kmw WINDY GAP MEMBER (UPPER CRETACEOUS?) OF MIDDLE PARK FORMATION—Andesitic breccia and conglomerate
Kls LEWIS SHALE
Kmv MESAVERDE FORMATION, UNDIVIDED—Major coal beds in lower part; Rollins Sandstone Member at base in Delta, Gunnison and Pitkin Counties
Kmv MESAVERDE GROUP OR FORMATION
Kmvu Upper part—In Moffat and Rio Blanco Counties, sandstone, shale, and coal beds above Sego Sandstone. Along Grand Hogback south of Colorado River, sandstone and shale above coal-bearing sequence
Kmvl Lower part—Sandstone, shale, and major coal beds

NORTHWEST AND WEST-CENTRAL (Continued)

Kw WILLIAMS FORK FORMATION—Sandstone, shale, and major coal beds
Ki ILES FORMATION—Sandstone and shale. Trout Creek Sandstone Member at top; coal beds in upper half
Ksc SEGO SANDSTONE, BUCK TONGUE OF MANCOS SHALE, AND CASTLEGATE SANDSTONE
Kh HUNTER CANYON FORMATION—Sandstone and shale
Kmgs MOUNT GARFIELD FORMATION AND SEGO SANDSTONE—Sandstone and shale; major coal beds in lower part of Mount Garfield
Km MANCOS SHALE—Intertongues complexly with units of overlying Mesaverde Group or Formation; lower part consists of a calcareous Niobrara equivalent and Frontier Sandstone and Mowry Shale Members in areas where the Frontier and Mowry Members (Kmfm), or these and the Dakota Sandstone (Kfd) are distinguished, map unit (Km) refers to the shale above Frontier Member
Kmfm Frontier Sandstone and Mowry Shale Members and intervening shale zone
Kd DAKOTA SANDSTONE
Kfd FRONTIER SANDSTONE AND MOWRY SHALE MEMBERS OF MANCOS SHALE AND DAKOTA SANDSTONE—Locally includes, at base, Burro Canyon Formation (sandstone and conglomerate) and, in western Moffat County, includes the Cedar Mountain Formation (conglomerate and shale)
Kdb DAKOTA SANDSTONE AND BURRO CANYON FORMATION—Sandstone, shale, and conglomerate

SOUTHWEST

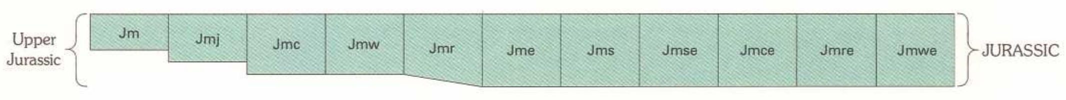
Kkf KIRTLAND SHALE AND FRUITLAND FORMATION—Sandstone, shale, and major coal beds
Kpcl PICTURED CLIFFS SANDSTONE AND LEWIS SHALE
Kch CLIFF HOUSE SANDSTONE
Kmp MENEFEE FORMATION (SANDSTONE, SHALE, AND COAL) AND POINT LOOKOUT SANDSTONE
Kmv MESAVERDE GROUP, UNDIVIDED—Sandstone and shale
Km MANCOS SHALE—Lower part contains Juana Lopez Member (Kmj)
Kmj Juana Lopez Member—Calcarenous sandstone; a thin but persistent unit distinguished only locally
Kdb DAKOTA SANDSTONE AND BURRO CANYON FORMATION—Sandstone, shale, and conglomerate



SEDIMENTARY ROCKS OF CRETACEOUS AND JURASSIC AGES

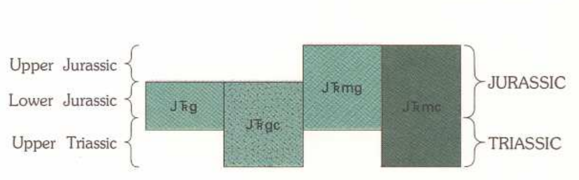
See under headings immediately preceding and following for compositions and age designations of formations

KJdm DAKOTA AND MORRISON FORMATIONS
KJdj DAKOTA, BURRO CANYON, MORRISON, AND JUNCTION CREEK FORMATIONS—Burro Canyon is locally absent
KJdw DAKOTA, BURRO CANYON, MORRISON, AND WANAKAH FORMATIONS
KJdr DAKOTA, MORRISON, AND RALSTON CREEK FORMATIONS AT MOUNTAIN FRONT BETWEEN BOULDER AND COLORADO SPRINGS
DAKOTA, PURGATOIRE, MORRISON, AND RALSTON CREEK FORMATIONS IN CANON CITY AREA
KJde DAKOTA, PURGATOIRE, MORRISON, RALSTON CREEK, AND ENTRADA FORMATIONS IN SOUTHEAST
DAKOTA, MORRISON, AND ENTRADA FORMATIONS IN CENTRAL MOUNTAINS
DAKOTA, BURRO CANYON, MORRISON, WANAKAH, AND ENTRADA FORMATIONS IN SOUTHWEST
DAKOTA, MORRISON, CURTIS, AND ENTRADA FORMATIONS IN NORTHWEST
KJds DAKOTA, MORRISON, AND SUNDANCE FORMATIONS



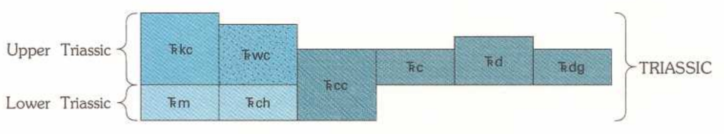
SEDIMENTARY ROCKS OF JURASSIC AGE

Jm MORRISON FORMATION—Variegated claystone, mudstone, sandstone, and local beds of limestone
Jmj MORRISON FORMATION AND JUNCTION CREEK SANDSTONE—In Gunnison River area east of wedgeout of all units of Wanakah Formation (Jmw) except the Pony Express Limestone Member
Jmc MORRISON AND CURTIS FORMATION (GLAUCONITIC SANDSTONE AND LIMESTONE)
Jmw MORRISON AND WANAKAH FORMATION (SANDSTONE, SHALE, LIMESTONE, AND LOCAL GYPSUM; JUNCTION CREEK SANDSTONE MEMBER AT OR NEAR TOP; PONY EXPRESS LIMESTONE MEMBER AT BASE)
Jmr MORRISON FORMATION AND RALSTON CREEK FORMATION (CLAYSTONE, SANDSTONE, LIMESTONE, AND GYPSUM)
Jme MORRISON FORMATION AND ENTRADA SANDSTONE
Jms MORRISON FORMATION AND SUNDANCE FORMATION (SANDSTONE, SHALE, CLAYSTONE, AND LIMESTONE)
Jmse MORRISON FORMATION, SUMMERVILLE FORMATION (SHALE AND SILTSTONE), AND ENTRADA SANDSTONE
Jmce MORRISON, CURTIS, AND ENTRADA FORMATIONS—In extreme southwestern Moffat County, includes thin wedge of Carmel Formation (red siltstone and sandstone) beneath Entrada
Jmre MORRISON, RALSTON CREEK, AND ENTRADA (OR EXETER) FORMATIONS
Jmwe MORRISON, WANAKAH, AND ENTRADA FORMATIONS



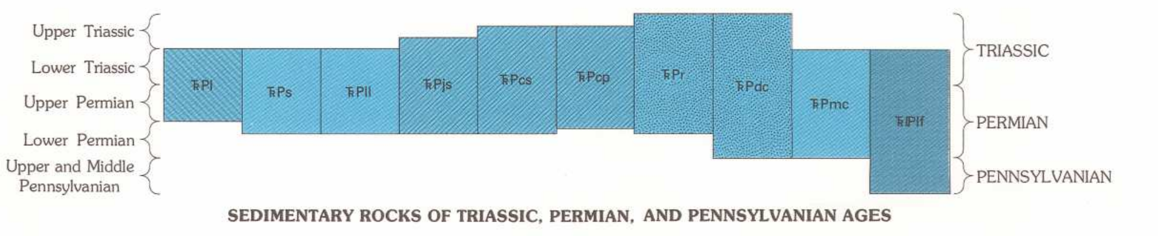
SEDIMENTARY ROCKS OF JURASSIC AND TRIASSIC AGE

JTRg GLEN CANYON SANDSTONE—In northwest
JTRgc GLEN CANYON GROUP AND CHINLE FORMATION—In southwest. Glen Canyon Group consists of Navajo Sandstone, Kayenta Formation (red siltstone, shale, and sandstone), and Wingate Sandstone; Chinle is red siltstone
JTRmg MORRISON, CURTIS, ENTRADA, AND GLEN CANYON FORMATIONS—Curtis is absent along Grand Hogback
JTRmc MORRISON, ENTRADA, AND CHINLE FORMATIONS—Along southern Grand Hogback, Chinle is represented only by basal Gartra Sandstone Member



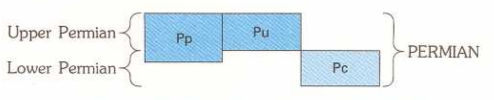
SEDIMENTARY ROCKS OF TRIASSIC AGE

TRkc KAYENTA FORMATION (RED SILTSTONE, SHALE, AND SANDSTONE), WINGATE SANDSTONE, AND CHINLE FORMATION (RED SILTSTONE AND SANDSTONE)
TRwc WINGATE SANDSTONE AND CHINLE FORMATION
TRm MOENKOPI FORMATION—Red siltstone, sandstone and local gypsum
TRch CHUGWATER FORMATION—Red sandstone, siltstone, shale, and local limestone and gypsum
TRcc CHINLE AND CHUGWATER FORMATIONS
TRc CHINLE FORMATION—Red siltstone, sandstone, and limestone-pellet conglomerate
TRd DOLORES FORMATION—Red siltstone, shale, sandstone, and limestone-pellet conglomerate
TRdg DOCKUM GROUP—Red sandstone, siltstone, and local limestone



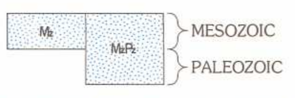
SEDIMENTARY ROCKS OF TRIASSIC, PERMIAN, AND PENNSYLVANIAN AGES

TRPl LYKINS FORMATION—Red siltstone, shale, and limestone
TRPs STATE BRIDGE FORMATION—Red and orange siltstone and sandstone
TRPlt LYKINS FORMATION AND LYONS SANDSTONE
TRPjs JELM, LYKINS, LYONS AND SATANKA FORMATIONS—Red siltstone, shale, and sandstone
TRPcs CHINLE AND STATE BRIDGE FORMATIONS—Red siltstone and sandstone
TRPcp CHINLE, MOENKOPI, AND PARK CITY FORMATIONS—Red and gray siltstone, shale and sandstone
TRPr TRIASSIC AND PERMIAN ROCKS—Red siltstone, shale, sandstone, and includes various combinations of Nugget, Jelm, Popo Agie, Chugwater, Red Peak, Forelle, Satanka, and Goose Egg Formations near Wyoming border
TRPdc DOLORES FORMATION (UPPER TRIASSIC) AND CUTLER FORMATION (LOWER PERMIAN)—Red siltstone, sandstone, and conglomerate
TRPmc MOENKOPI FORMATION (LOWER TRIASSIC) AND CUTLER FORMATION (LOWER PERMIAN)—Red siltstone and sandstone
TRPlf LYKINS, LYONS, AND FOUNTAIN FORMATIONS—Red siltstone, sandstone, and conglomerate



SEDIMENTARY ROCKS OF PERMIAN AGE

Pp PARK CITY FORMATION—Calcareous siltstone and sandstone
Pu UPPER PERMIAN ROCKS, UNDIVIDED—Siltstone, dolomite, and sandstone; in southeast
Pc CUTLER FORMATION—Arkosic sandstone, siltstone, and conglomerate



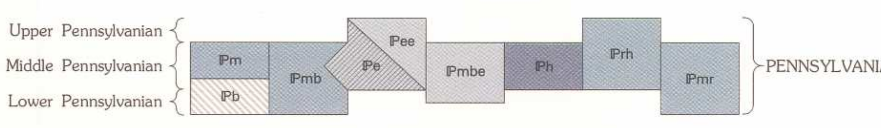
SEDIMENTARY ROCKS BROADLY CLASSIFIED

Shown in small areas of complex structure

Mz MESOZOIC ROCKS—Mainly Lower Cretaceous, Jurassic, and Triassic formations
MzPz MESOZOIC AND PALEOZOIC ROCKS—Mainly as in Mesozoic unit (Mz) plus Permian and Pennsylvanian formations

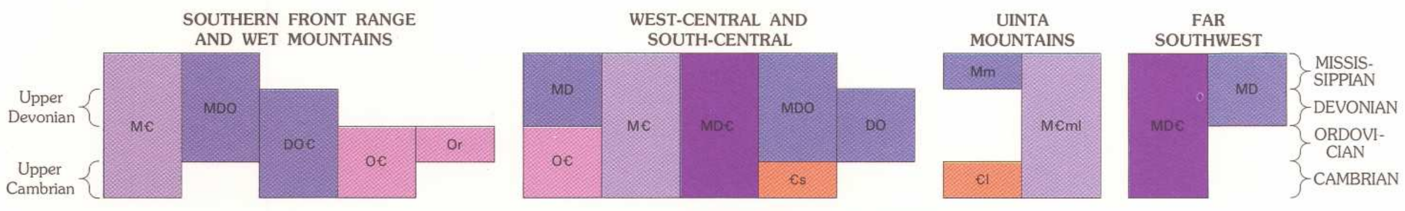
SEDIMENTARY ROCKS OF PERMIAN AND PENNSYLVANIAN AGE

PIPf FOUNTAIN FORMATION—Arkosic sandstone and conglomerate
PIPcf CASPER FORMATION (SANDSTONE) AND LOWER PART OF FOUNTAIN FORMATION
PIPif INGLESIDE FORMATION (LIMESTONE AND CALCAREOUS SANDSTONE) AND FOUNTAIN FORMATION
PIPs SANGRE DE CRISTO FORMATION—Arkosic conglomerate, sandstone, and siltstone
PIPm MAROON FORMATION—Arkosic sandstone, siltstone, conglomerate, and local limestone
PIPw WEBER SANDSTONE
PIPwm WEBER SANDSTONE AND MAROON FORMATION



SEDIMENTARY ROCKS OF PENNSYLVANIAN AGE

IPm MINTURN FORMATION IN WEST-CENTRAL AND SOUTH-CENTRAL AND OTHER UNITS OF MIDDLE PENNSYLVANIAN AGE—Arkosic sandstone, conglomerate, shale, and limestone. Includes Madera Formation and Sharpsdale Formation of Chronic (1958) in Sangre de Cristo Range and Gothic Formation of Langenheim (1952) in Elk Mountains
IPb BELDEN FORMATION—Shale, limestone, and sandstone. Includes Kerber Formation in south-central
IPmb MINTURN AND BELDEN FORMATIONS
IPe EAGLE VALLEY FORMATION—Siltstone, shale, and local gypsum
IPee EVAPORITIC FACIES—Gypsum, siltstone, and shale; salt present in deep borings. Intertongues with Minturn and Lower Maroon Formations. Diapiric structure in many places
IPmbe EVAPORITIC FACIES OF MINTURN AND BELDEN FORMATIONS IN SOUTH PARK AND SOUTHWARD—Gypsum, siltstone, and shale
IPh HERMOSA FORMATION—Arkosic sandstone, conglomerate, shale, and limestone; gypsum and salt in Paradox Member present in salt anticlines near Utah border
IPrh RICO AND HERMOSA FORMATIONS—Arkosic sandstone, conglomerate, shale, and limestone. Includes at base in some areas siltstone and shale of Molas Formation, or Larsen Quartzite
IPmr MORGAN FORMATION (LIMESTONE, SANDSTONE, AND SHALE) AND ROUND VALLEY LIMESTONE—In far northwest



SEDIMENTARY ROCKS OF PRE-PENNSYLVANIAN PALEOZOIC AGE

SOUTHERN FRONT RANGE AND WET MOUNTAINS

M€ LEADVILLE LIMESTONE (MISSISSIPPIAN), WILLIAMS CANYON LIMESTONE (DEVONIAN), MANITOU LIMESTONE (ORDOVICIAN), AND SAWATCH QUARTZITE (CAMBRIAN)
MDO LEADVILLE LIMESTONE, WILLIAMS CANYON LIMESTONE, AND ONE OR MORE ORDOVICIAN FORMATIONS: FREMONT LIMESTONE, HARDING SANDSTONE, AND MANITOU LIMESTONE
DO€ WILLIAMS CANYON LIMESTONE, MANITOU LIMESTONE, AND SAWATCH QUARTZITE
O€ MANITOU LIMESTONE AND SAWATCH QUARTZITE
Or ONE OR MORE ORDOVICIAN FORMATIONS—Fremont Limestone, Harding Sandstone, and Manitou Limestone

WEST-CENTRAL AND SOUTH-CENTRAL

MD LEADVILLE LIMESTONE (MISSISSIPPIAN), GILMAN SANDSTONE (MISSISSIPPIAN OR DEVONIAN), DYER DOLOMITE (MISSISSIPPIAN? AND DEVONIAN), AND PARTING FORMATION (DEVONIAN, QUARTZITE AND SHALE)
O€ ONE OR MORE ORDOVICIAN FORMATIONS (FREMONT LIMESTONE, HARDING SANDSTONE, AND MANITOU DOLOMITE), DOTSERO FORMATION (CAMBRIAN, DOLOMITE; IN WHITE RIVER PLATEAU ONLY), PEERLESS FORMATION (CAMBRIAN, SANDSTONE AND DOLOMITE), AND SAWATCH QUARTZITE (CAMBRIAN)

WEST-CENTRAL AND SOUTH-CENTRAL (Continued)

M€ LEADVILLE, GILMAN, DYER, PARTING, FREMONT, HARDING, MANITOU, DOTSERO, PEERLESS, AND SAWATCH FORMATIONS; SOME FORMATIONS ABSENT LOCALLY
MD€ LEADVILLE, GILMAN, DYER, PARTING, AND SAWATCH FORMATIONS
MDO LEADVILLE, GILMAN, DYER, PARTING, FREMONT, HARDING, AND MANITOU FORMATIONS
DO PARTING, FREMONT, AND HARDING FORMATIONS
€s SAWATCH QUARTZITE—Locally includes Peerless Formation

UINTA MOUNTAINS

Mm MADISON LIMESTONE (MISSISSIPPIAN)—Upper part includes equivalents of Upper Mississippian Doughnut and Humbug Formations (shale, limestone, and sandstone)
€l LODORE FORMATION (CAMBRIAN)—Sandstone, shale, and conglomerate
M€ml MADISON LIMESTONE AND LODORE FORMATION

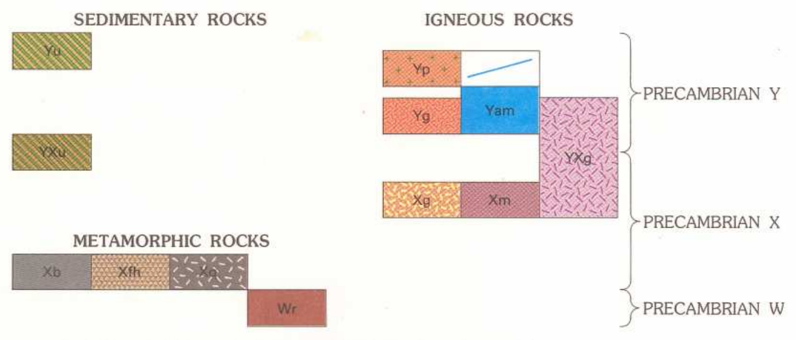
FAR SOUTHWEST

MD€ LEADVILLE LIMESTONE (MISSISSIPPIAN), OURAY LIMESTONE (DEVONIAN), ELBERT FORMATION (DEVONIAN, SHALE AND SANDSTONE), AND IGNACIO QUARTZITE (CAMBRIAN)
MD LEADVILLE, OURAY, AND ELBERT FORMATIONS

€am CAMBRIAN

IGNEOUS ROCKS OF CAMBRIAN AGE

€am Alkalic and mafic intrusive rocks in small plutons, and diabase dikes (age 510–570 m.y.)



SEDIMENTARY, METAMORPHIC, AND IGNEOUS ROCKS OF PRECAMBRIAN AGE

SEDIMENTARY ROCKS

Yu UINTA MOUNTAIN GROUP (AGE 950–1,400 M.Y.)—Quartzite, conglomerate, and shale
YXu UNCOMPAHGRE FORMATION (OLDER THAN GRANITES OF 1,400–M.Y. AGE GROUP AND YOUNGER THAN GRANITES OF 1,700–M.Y. AGE GROUP)—Quartzite, slate, and phyllite

METAMORPHIC ROCKS (Age 1,700–1,800 m.y.)

Xb BIOTITIC GNEISS, SCHIST, AND MIGMATITE—Locally contains minor hornblende gneiss, calc-silicate rock, quartzite, and marble. Derived principally from sedimentary rocks
Xfh FELSIC AND HORNBLENDIC GNEISSES, EITHER SEPARATE OR INTERLAYERED—Includes metabasalt, metatuff, and interbedded metagraywacke; locally contains interlayered biotite gneiss. Derived principally from volcanic rocks
Xq QUARTZITE, CONGLOMERATE, AND INTERLAYERED MICA SCHIST

Age probably >2,500 m.y.

Wr RED CREEK QUARTZITE—Metaquartzite, amphibolite, and mica schist. Present only in small area at Utah border in Uinta Mountains

IGNEOUS ROCKS

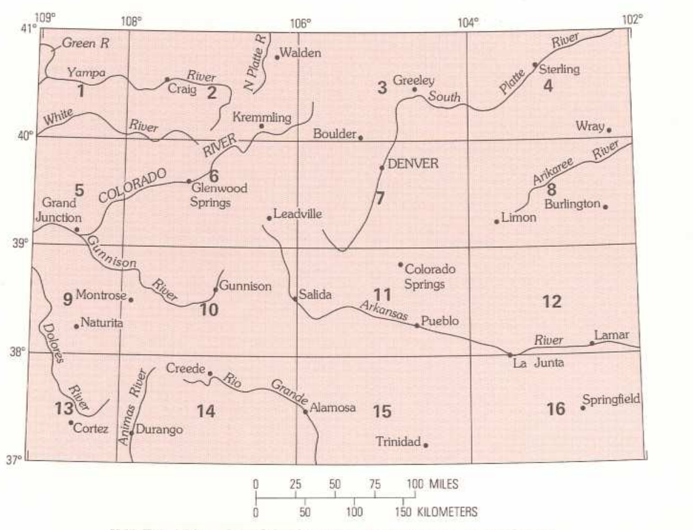
Yp ROCKS OF PIKES PEAK BATHOLITH (1,000–M.Y. AGE GROUP)—Includes Pikes Peak, Mount Rosa, Windy Point, and Redskin Granites and unnamed rocks
Yg GRANITIC ROCKS OF 1,400–M.Y. AGE GROUP (AGE 1,350–1,480 M.Y.)—Includes Silver Plume, Sherman, Cripple Creek, St. Kevin, Vernal Mesa, Curecanti, Eolus, and Trimble Granites or Quartz Monzonites; also, San Isabel Granite of Boyer (1962) and unnamed granitic rocks
Yam ALKALIC AND MAFIC ROCKS IN SMALL PLUTONS, AND DIABASE AND GABBRO DIKES
Xg GRANITIC ROCKS OF 1,700–M.Y. AGE GROUP (AGE 1,650–1,730 M.Y.)—Includes Boulder Creek, Cross Creek, Denny Creek, Kroenke, Browns Pass, Powderhorn, Pitts Meadow, Bakers Bridge, and Tenmile Granites, Quartz Monzonites, or Granodiorites; also, unnamed granitic rocks
Xm MAFIC ROCKS OF 1,700–M.Y. AGE GROUP—Gabbro and mafic diorite and monzonite
YXg GRANITIC ROCKS OF 1,400– AND 1,700–M.Y. AGE GROUPS, UNDIVIDED, OR, IN TAYLOR RIVER REGION, ROCKS WITH CHARACTERISTICS OF Xg BUT U-Th-Pb ZIRCON AGES OF Yg

S Y M B O L S

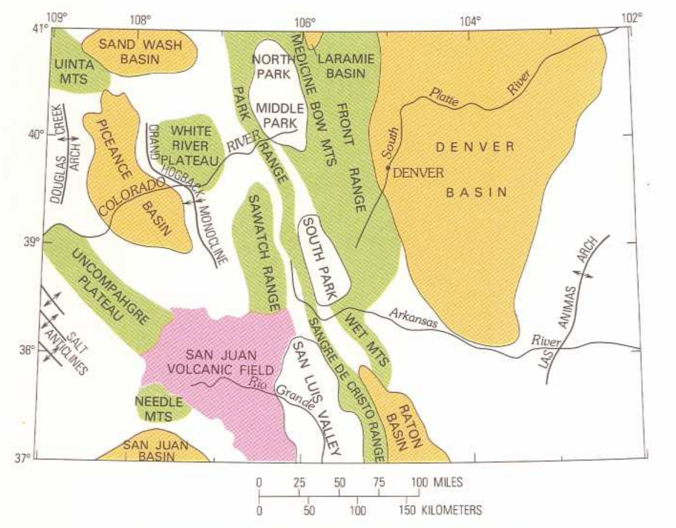
CONTACT
FAULT—Dotted where concealed. Bar and ball on downthrown side
LOW-ANGLE THRUST FAULT—Dotted where concealed. Sawteeth on upper plate
INFERRED FAULT IN AND BENEATH VALLEY-FILL DEPOSITS—Bar and ball on downthrown side
PRECAMBRIAN SHEAR ZONE
FOLD LINES—General locations of major folds shown where space allows. Dotted where concealed
ANTICLINE
OVERTURNED SYNCLINE
SYNCLINE
MONOCLINE
VOLCANIC CINDER CONE OR CRATER (AGE <1.8 M.Y.)—In Costilla and Eagle Counties
VOLCANIC NECK (AGE 7–10 M.Y.)—In southern Routt County
DIATREME (PRE-UPPER DEVONIAN, POST-MIDDLE SILURIAN)—In northern Larimer County

R E F E R E N C E S

Berggren, W. A., 1972, A Cenozoic time-scale—some implications for regional geology and paleobiogeography: Lethaia, v. 5, no. 2, p. 195–215.
Boyer, R. E., 1962, Petrology and structure of the southern Wet Mountains, Colorado: Geol. Soc. America Bull., v. 73, no. 9, p. 1047–1070.
Chronic, B. J., Jr., 1958, Pennsylvanian rocks in central Colorado, in Rocky Mt. Assoc. Geologists, Symposium on Pennsylvanian rocks of Colorado and adjacent areas, p. 59–63.
Lambert, R. S. J., 1971, The pre-Pleistocene Phanerozoic time-scale—A review, in Part 1 of the Phanerozoic time-scale—A supplement: Geol. Soc. London Spec. Pub. 5, p. 9–34.
Langenheim, R. L., Jr., 1952, Pennsylvanian and Permian stratigraphy in Crested Butte quadrangle, Gunnison County, Colorado: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 4, p. 543–574.



INDEX MAP OF COLORADO SHOWING PRINCIPAL SOURCES OF GEOLOGIC DATA



LOCATION MAP OF MAJOR TECTONIC AND GEOGRAPHIC FEATURES

PRINCIPAL SOURCES OF GEOLOGIC DATA

Geologic data for the Colorado map were derived principally from compilations of 1°×2° quadrangles, references to which are given below. The individual 1°×2° quadrangle maps in turn incorporate many other maps, references to which may be found on the 1°×2° quadrangle maps. All quadrangle maps have been generalized as necessary to fit requirements of scale, and some have been modified or amplified from sources included under the quadrangle headings.

1. Vernal quadrangle
Tweto, Ogden, 1976, Preliminary geologic map of east half of Vernal 1°×2° quadrangle, Colorado: U.S. Geol. Survey Open-file Rept. 75-588.
Supplementary data from:
Rowley, P. D., and Hansen, W. R., U.S. Geological Survey unpub. maps of parts of quadrangle.
2. Craig quadrangle
Tweto, Ogden, 1976, Geologic map of the Craig 1°×2° quadrangle, northwestern Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-972.
Supplementary data from:
Snyder, G. L., U.S. Geol. Survey unpub. map of Steamboat Springs-Oak Creek-Rabbit Ears Peak area.
3. Greeley quadrangle
Interim compilation by Ogden Tweto from:
Abbott, J. T., 1976, Geologic map of the Big Narrows quadrangle, Larimer County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-1323.
Beckwith, R. H., 1942, Structure of the upper Laramie River valley, Colorado-Wyoming: Geol. Soc. America Bull., v. 53, no. 10, p. 1491–1532.
Birch, Alvin, Colorado State Univ., unpublished map of parts of Deadman and South Bald Mountain quadrangles, Larimer County, Colorado.
Bjorklund, L. J., and Brown, R. F., 1957, Geology and ground-water resources of the lower South Platte River Valley between Hardin, Colorado, and Paxton, Nebraska, with a section on Chemical quality of the ground water, by H. A. Swenson: U.S. Geol. Survey Water-Supply Paper 1378, 431 p.
Braddock, W. A., Calvert, R. H., Gawarecki, S. J., and Nutalaya, Prinya, 1970, Geologic map of the Masonville quadrangle, Larimer County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-832.
Braddock, W. A., Calvert, R. H., O'Connor, J. T., and Swann, G. A., 1973, Geologic map and sections of the Laporte quadrangle, Larimer County, Colorado: U.S. Geol. Survey open-file map.
Braddock, W. A., Connor, J. J., Swann, G. A., and Wohlford, D. D., 1973, Geologic map and sections of the Horsetooth Reservoir quadrangle, Larimer County, Colorado: U.S. Geol. Survey open-file map.
Braddock, W. A., Nutalaya, Prinya, Gawarecki, S. J., and Curtin, G. C., 1970, Geologic map of the Drake quadrangle, Larimer County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-829.
Colton, R. B., and Lowrie, R. L., 1973, Map showing mined areas of the Boulder-Weld coal field, Colorado: U.S. Geol. Survey Misc. Field Studies Map MF-513.
Eggler, D. H., 1968, Virginia Dale ring-dike complex, Colorado-Wyoming: Geol. Soc. America Bull., v. 79, no. 11, p. 1545–1564.
Gable, D. J., and Madole, R. F., 1976, Geologic map of the Ward quadrangle, Boulder County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-1277.
Hershey, L. A., and Schneider, P. A., Jr., 1972, Geologic map of the lower Cache la Poudre River basin, north-central Colorado: U.S. Geol. Survey Misc. Inv. Map I-687.
Hunter, Z. M., 1955, Geology of the foothills of the Front Range in northern Colorado: Rocky Mtn. Assoc. Geologists, Denver, Colorado, 2 map sheets.
Izett, G. A., 1974, Geologic map of the Trail Mountain quadrangle, Grand County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-1156.
Lovering, T. S., and Goddard, E. N., 1950, Geology and ore deposits of the Front Range, Colorado: U.S. Geol. Survey Prof. Paper 223, 319 p. [1951].
O'Neil, J. M., Colorado Univ., unpublished map of Mount Richthofen quadrangle, Grand and Jackson Counties, Colorado.
Pearson, R. C., and Speltz, C. N., 1975, Mineral resources of the Indian Peaks study area, Boulder and Grand Counties, Colorado, with a section on Interpretation of aeromagnetic data, by Gordon Johnson: U.S. Geol. Survey Open-file Rept. 75-500.
Pipiringos, G. N., and O'Sullivan, R. B., 1976, Stratigraphic sections of some Triassic and Jurassic rocks from Douglas, Wyoming, to Boulder, Colorado: U.S. Geol. Survey Oil and Gas Inv. Chart OC-69.
Scott, G. R., and Cobban, W. A., 1965, Geologic and biostratigraphic map of the Pierre Shale between Jarre Creek and Loveland, Colorado: U.S. Geol. Survey Misc. Geol. Inv. Map I-439.
Smith, R. O., Schneider, P. A., Jr., and Petrie, L. R., 1964, Ground-water resources of the South Platte River basin in western Adams and southwestern Weld Counties, Colorado: U.S. Geol. Survey Water-Supply Paper 1658, 132 p.
Soister, P. E., 1965, Geologic map of the Fort Lupton quadrangle, Weld and Adams Counties, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-397.
———1965, Geologic map of the Hudson quadrangle, Weld and Adams Counties, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-398.
———1965, Geologic map of the Platteville quadrangle, Weld County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-399.
Trimble, D. E., 1975, Geologic map of the Niwot quadrangle, Boulder County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-1229.
Weist, W. G., Jr., 1965, Reconnaissance of the ground-water resources in parts of Larimer, Logan, Morgan, Sedgwick, and Weld Counties, Colorado, with a section on The chemical quality of the water, by Robert Brennan: U.S. Geol. Survey Water-Supply Paper 1809-L, 24 p.
Wrucke, C. T., and Wilson, R. F., 1964, Geologic map of the Boulder quadrangle, Boulder County, Colorado: U.S. Geol. Survey open-file map.
U.S. Geol. Survey unpub. maps by W. A. Braddock, R. B. Colton, D. J. Gable, N. M. Denson, D. M. Kinney, M. E. McCallum, R. C. Pearson, G. R. Scott, and Ogden Tweto.
4. Sterling quadrangle
Scott, G. R., 1978, Geologic map of the Sterling 1°×2° quadrangle, northeastern Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-1092. (In press).
5. Grand Junction quadrangle
Cashion, W. B., 1973, Geologic and structure map of the Grand Junction quadrangle, Colorado and Utah: U.S. Geol. Survey Misc. Geol. Inv. Map I-736.
6. Leadville quadrangle
Tweto, Ogden, Moench, R. H., and Reed, J. C., Jr., 1978, Geologic map of the Leadville 1°×2° quadrangle, northwestern Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-999.
7. Denver quadrangle
Bryant, Bruce, U.S. Geol. Survey unpub. compilation of northwest part of quadrangle.
Bryant, Bruce, and Wobus, R. A., 1975, Preliminary geologic map of the southwestern quarter of the Denver 1°×2° quadrangle, Colorado: U.S. Geol. Survey Open-file Rept. 75-340.
McGrew, L. W., U.S. Geol. Survey unpub. map of eastern part of quadrangle.
Soister, P. E., U.S. Geol. Survey unpub. maps of Denver and Dawson Formations.
Trimble, D. E., U.S. Geol. Survey unpub. map of Front Range Urban Corridor, Greater Denver and Colorado Springs-Castle Rock areas.
8. Limon quadrangle
Sharps, J. A., U.S. Geol. Survey unpub. map of quadrangle.
9. Moab quadrangle
Williams, P. L., 1964, Geology, structure, and uranium deposits of the Moab quadrangle, Colorado and Utah: U.S. Geol. Survey Misc. Geol. Inv. Map I-360.
Supplementary data on Precambrian rocks from:
Case, J. E., 1966, Geophysical anomalies over Precambrian rocks, northwestern Uncompahgre Plateau, Utah and Colorado: Am. Assoc. Petroleum Geologists Bull., v. 50, no. 7, p. 1423–1443.
Hedge, C. E., Peterman, Z. E., Case, J. E., and Obradovich, J. D., 1968, Precambrian geochronology of the northwestern Uncompahgre Plateau, Utah and Colorado, in Geological Survey research 1968: U.S. Geol. Survey Prof. Paper 600-C, p. C91–C96.
Mose, D. G., and Bickford, M. E., 1969, Precambrian geochronology in the Unaweep Canyon, west-central Colorado: Jour. Geophysical Research, v. 74, no. 6, p. 1677–1687.
10. Montrose quadrangle
Tweto, Ogden, Steven, T. A., Hail, W. J., Jr., and Moench, R. H., 1976, Preliminary geologic map of the Montrose 1°×2° quadrangle, southwestern Colorado: U.S. Geol. Survey Misc. Field Studies Map MF-761.
11. Pueblo quadrangle
Scott, G. R., Taylor, R. B., Epis, R. C., and Wobus, R. A., 1978, Geologic map of the Pueblo 1°×2° quadrangle, south-central Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-1022.
12. Lamar quadrangle
Sharps, J. A., 1976, Geologic map of the Lamar quadrangle, Colorado and Kansas: U.S. Geol. Survey Misc. Inv. Series Map I-944.
Supplementary data on bedrock from:
Boettcher, A. J., 1964, Geology and ground-water resources in eastern Cheyenne and Kiowa Counties, Colorado, with a section on Chemical quality of the ground water, by C. A. Horr: U.S. Geol. Survey Water-Supply Paper 1779-N, 32 p.
Coffin, D. L., 1967, Geology and ground-water resources of the Big Sandy Creek valley, Lincoln, Cheyenne, and Kiowa Counties, Colorado, with a section on Chemical quality of the ground water, by C. A. Horr: U.S. Geol. Survey Water-Supply Paper 1843, 49 p.
Voegeli, P. T., Sr., and Hershey, L. A., 1965, Geology and ground-water resources of Prowers County, Colorado: U.S. Geol. Survey Water-Supply Paper 1772, 101 p.
Weist, W. G., Jr., 1965, Geology and occurrence of ground water in Otero County and the southern part of Crowley County, Colorado, with sections on Hydrology of the Arkansas River valley in the project area, by W. G. Weist, Jr., and E. D. Jenkins; Hydraulic properties of the water-bearing materials, by E. D. Jenkins; and Quality of the ground water, by C. A. Horr: U.S. Geol. Survey Water-Supply Paper 1799, 90 p.
13. Cortez quadrangle
Haynes, D. D., Vogel, J. D., and Wyant, D. G., 1972, Geology, structure, and uranium deposits of the Cortez quadrangle, Colorado and Utah: U.S. Geol. Survey Misc. Geol. Inv. Map I-629.
14. Durango quadrangle
Steven, T. A., Lipman, P. W., Hail, W. J., Jr., Barker, Fred, and Luedke, R. G., 1974, Geologic map of the Durango quadrangle, southwestern Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-764.
Supplementary data on surficial deposits from:
Atwood, W. W., and Mather, K. F., 1932, Physiography and Quaternary geology of the San Juan Mountains, Colorado: U.S. Geol. Survey Prof. Paper 166, 176 p.
Richmond, G. M., 1965, Quaternary stratigraphy of the Durango area, San Juan Mountains, Colorado, in Geological Survey Research 1965: U.S. Geol. Survey Prof. Paper 525-C, p. C137–C143.
15. Trinidad quadrangle
Johnson, R. B., 1969, Geologic map of the Trinidad quadrangle, south-central Colorado: U.S. Geol. Survey Misc. Geol. Inv. Map I-558.
Supplementary data from:
Boyer, R. E., 1962, Petrology and structure of the southern Wet Mountains, Colorado: Geol. Soc. America Bull., v. 73, no. 9, p. 1047–1070.
Burroughs, R. L., 1971, Geology of the San Luis Hills, south-central Colorado, in New Mexico Geol. Soc. Guidebook 22d Field Conf., San Luis Basin, Colorado, 1971: p. 277–287. Also, unpub. geologic map of San Luis Hills area.
Cochran, D. M., 1974, Charles S. Robinson and Associates, Inc., unpub. geologic map of Forbes Trinchera Ranch.
Gaca, J. R., and Karig, D. E., 1966, Gravity survey in the San Luis Valley area, Colorado: U.S. Geol. Survey open-file report, 22 p.
Kleinkopf, M. D., Peterson, D. L., and Johnson, R. B., 1970, Reconnaissance geophysical studies of the Trinidad quadrangle, south-central Colorado: U.S. Geol. Survey Prof. Paper 700-B, p. B78–B85.
McCulloch, D. S., 1963, Late Cenozoic history of Huerfano Park, Colorado: Michigan Univ. Ph.D. thesis, 158 p.
Scott, G. R., and Taylor, R. B., 1975, Post-Paleocene Tertiary rocks and Quaternary volcanic ash of the Wet Mountain Valley, Colorado: U.S. Geol. Survey Prof. Paper 868, 15 p.
Tweto, Ogden, U.S. Geol. Survey reconnaissance mapping.
Vine, J. D., 1974, Geologic map and cross sections of the LaVeta Pass, LaVeta, and Ritter Arroyo quadrangles, Huerfano and Costilla Counties, Colorado: U.S. Geol. Survey Misc. Inv. Series Map I-833.
16. LaJunta quadrangle
Scott, G. R., 1968, Geologic and structure contour map of the LaJunta quadrangle, Colorado and Kansas: U.S. Geol. Survey Misc. Geol. Inv. Map I-560.