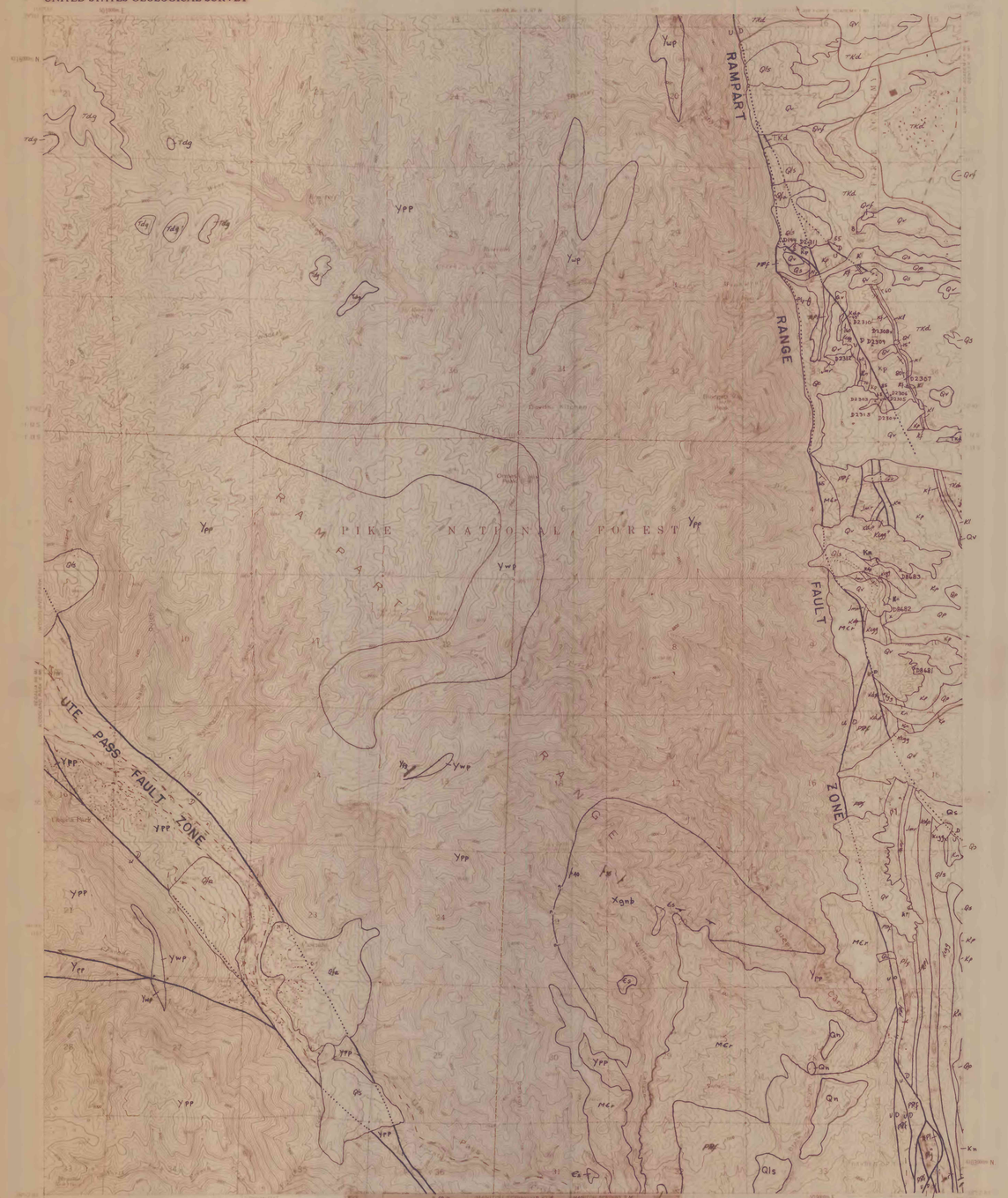
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN-FILE REPORT
77-138
CASCADE QUAD., COLORADO



Base from U.S. Geological Survey, 1961.

Geology mapped in 1971. Some contacts modified from Blair (1975), Grose (1960), Scott and Wobus (1973), and Varnes and Scott (1967), which shows detailed surficial mapping.

U.S. Geological Survey
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This map is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

RECONNAISSANCE GEOLOGIC MAP OF THE CASCADE QUADRANGLE, EL PASO COUNTY, COLORADO

By
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1977

CORRELATION OF MAP UNITS

Qp, Qc, Qfs	Holocene	QUATERNARY
UNCONFORMITY		
Qls, Qs	Holocene	QUATERNARY
UNCONFORMITY		
Qv	Pleistocene	QUATERNARY
UNCONFORMITY		
Qrf	Pleistocene	QUATERNARY
UNCONFORMITY		
Qm	Pleistocene	QUATERNARY
UNCONFORMITY		
Tdg	Middle Pliocene(?) to Upper Miocene(?)	TERTIARY
UNCONFORMITY		
Tkd	Paleocene	TERTIARY
UNCONFORMITY		
Kl	Upper Cretaceous	CRETACEOUS
Kf	Upper Cretaceous	CRETACEOUS
Kp	Upper Cretaceous	CRETACEOUS
Kn	Upper Cretaceous	CRETACEOUS
UNCONFORMITY		
Kcgg	Lower Cretaceous	CRETACEOUS
Kdp	Lower Cretaceous	CRETACEOUS
UNCONFORMITY		
Jmr	Upper Jurassic	JURASSIC
UNCONFORMITY		
RPl	TRIASSIC	TRIASSIC
Ply	PERMIAN	PERMIAN
UNCONFORMITY		
PPf	PENNSYLVANIAN	PENNSYLVANIAN
UNCONFORMITY		
MCr	MISSISSIPPIAN AND DEVONIAN	MISSISSIPPIAN AND DEVONIAN
Ꞓs	ORDOVICIAN AND CAMBRIAN	ORDOVICIAN AND CAMBRIAN
UNCONFORMITY		
Yfg	>1.03 billion years	PRECAMBRIAN Y
Ypp	>1.03 billion years	PRECAMBRIAN Y
Ywp	>1.03 billion years	PRECAMBRIAN Y
Xgnb	>1.72 billion years	PRECAMBRIAN X

DESCRIPTION AND ENGINEERING GEOLOGY PROPERTIES OF MAP UNITS

Qp PINEY CREEK ALLUVIUM (UPPER HOLOCENE)--Gray to brown humus-rich firmly compacted clayey silt and sand. Contains pebble lenses in lower part. Unmapped deposits along smaller streams subject to flooding. Thickness as much as 20 feet (6 m). Top of terrace alluvium is about 20 feet (6 m) above major streams

Permeability medium to low. Easily excavated. Compressible where rich in humus; however, compaction generally is easy where humus is lacking. Foundation stability fair to poor for heavy structures; clayey parts of unit may have low to medium swelling properties when wetted. Foundation stability poor where close to arroyos and water courses. Slope stability poor to medium. Cut slopes stand vertically along deep arroyos when dry, but slump when the base is wetted. Check dams necessary to prevent erosion. Source of sand and gravel along large streams

Topographically lowest part of unit mapped adjacent to larger streams is called post-Piney Creek alluvium, but is undifferentiated here. It is sandier and less compacted than Piney Creek Alluvium; thickness more than 10 feet (3 m). Post-Piney Creek alluvium subject to seasonal flooding; also, a shallow water table locally might hinder the use of basements. Source of sand and gravel along large streams

Qc COLLUVIUM (UPPER HOLOCENE)--Reddish-brown bouldery, clayey coarse sand containing cobbles and pebbles, chiefly of Pikes Peak Granite south of West Monument Creek. Occurs on steep slopes

Permeability high. Excavation and compaction moderately difficult for small power equipment because of steep slopes and large boulders. Foundation stability fair to good. Deposits on steep slopes may be subject to landsliding if overloaded or wetted excessively. Resistance to erosion good owing to boulders and vegetative cover

Qfs FAN ALLUVIUM (UPPER HOLOCENE)--Reddish-brown bouldery, cobbly, pebbly coarse sand on steep slopes along mountain front and Fountain Creek

Permeability high. Excavation moderately difficult for small power equipment because of steep slopes and large boulders. Compaction moderately difficult because of large boulders and lack of fines. Foundation stability fair to good; deposits on steep slopes may be subject to landsliding if underlying clayey shale wetted excessively. Resistance to erosion fair

Qls LANDSLIDE DEPOSITS (UPPER HOLOCENE TO KANSAN GLACIATION)--Reddish- to yellowish-brown debris slides and earthflows chiefly on steep slopes along mountain front, on east flank of Dakota hogback, along edges of pediments, and along valley of Fountain Creek. All deposits bouldery and sandy, but clay and silt content varies from abundant, where slides involve shaly bedrock, to absent, where slides are derived from Pikes Peak Granite. Upper surface hummocky. Probably as much as 30 feet (9 m) thick

Permeability low to high depending on clay content. Excavation moderately difficult for small power equipment because of steep slopes and boulders. Compaction moderately difficult because of boulders. Foundation stability very poor to good, depending on moisture conditions, slope, and load imposed. Some deposits may be subject to further sliding depending on above three factors. In addition, some slopes that have not slid, but that are similar to those that have, may be potentially unstable under adverse load and moisture conditions and warrant investigation before any excavation or construction takes place. Earthquake stability for both existing slides and potentially unstable areas probably very poor. Resistance to erosion good if covered by boulders and vegetation; fair if vegetation lacking

Qs SLOGUM ALLUVIUM (PLEISTOCENE--SANGAMON INTERGLACIATION OR ILLINOIAN GLACIATION)--Moderately reddish-brown poorly sorted, moderately compacted, stratified gravel containing layers of clay, silt, and sand, and clay balls derived from shaly bedrock. Near mountains, gravel contains larger and more abundant boulders than to east. Stones are weathered and coated by calcium carbonate. Upper part of most deposits contains a calcareous soil. Thickness as much as 40 feet (12 m). Top of alluvial terrace or pediment gravel 80-120 feet (24-36 m) above major streams

Permeability high in gravel, but generally low in clayey and silty layers. Excavation and compaction generally easy except in bouldery deposits. Foundation stability good. Material in vertical cuts generally slumps to a slope of 25 degrees or less after a short time. Generally resistant to erosion. Source of sand and gravel

Qv VERDOS ALLUVIUM (PLEISTOCENE--YARMOUTH INTERGLACIATION OR KANSAN GLACIATION)--Brown poorly sorted, moderately compacted, stratified gravel containing lenses of sand, silt, and clay. Deposits near mountains contain largest stones. Stones are weathered and coated by calcium carbonate. Upper part of most deposits contains a calcareous soil. Thickness locally near 100 feet (30 m). Top of alluvial terrace or pediment gravel 160-200 feet (48-60 m) above major streams

Permeability high in gravel, but generally low in clay and silt lenses. Excavation and compaction generally easy except in bouldery deposits. Foundation stability good for small structures but subject to collapse of structure when wetted under heavy loads. Material in vertical cuts generally slumps to a slope of 25 degrees or less after a short time. Resistant to erosion. Source of sand and gravel

Qrf ROCKY FLATS ALLUVIUM (PLEISTOCENE--AFTONIAN INTERGLACIATION OR NEBRASKAN GLACIATION)--Reddish-brown pebble, cobble, and boulder gravel. Largest boulders near mountains. Alluvium poorly sorted, firmly compacted, and stratified. Stones altered and coated by calcium carbonate. Upper part of most deposite contains a calcareous soil. Thickness locally more than 50 feet (15 m). Top of alluvial terrace or pediment gravel lies 260-280 feet (78-84 m) above modern streams

Permeability moderately high. Excavation and compaction easy except where boulders are large. Foundation stability good. Slope stability good; excavations stand in vertical walls for months, but eventually slump to 25 degree slopes. Resistant to erosion. Source of sand and gravel

Qn NUSSBAUM ALLUVIUM (PLEISTOCENE--NEBRASKAN GLACIATION)--Brown well-stratified, fairly well sorted, weakly compacted coarse sand and pebble gravel between Williams Canyon and Queens Canyon, where gravel composed of fragments of Pikes Peak Granite, Precambrian biotite gneiss, and lower Paleozoic sandstone and limestone. Large boulders abundant near mountain front. Stones altered by weathering and coated by calcium carbonate. Upper part of most deposits contains a calcareous soil. Thickness more than 80 feet (24 m). Top of pediment gravel in this area 550-700 feet (165-210 m) above modern streams

Permeability good. Excavation and compaction easy except for some large boulders. Dusts badly when used as road metal. Foundation stability good. Slope stability fairly good; vertical cuts stand for a long time, then slump to a slope of 25 degrees or less. Fairly resistant to erosion. Source of sand and gravel

Tdg GRAVEL AT DIVIDE (MIDDLE PLIOCENE? TO UPPER MIOCENE?)--Brown clayey, silty, sandy gravel in extensive paleovalley on line with West Monument Creek. Poorly sorted, poorly stratified, firmly compacted. Covered almost exclusively by grass. Contains boulders as large as 3 feet (1 m) in lower gray part of channel fill, which possibly is Oligocene in age (Chadron--equivalent to Castle Rock Conglomerate). Finer part of gravel composed chiefly of Pikes Peak Granite, but contains metasedimentary rocks and other granitic rocks. Most of larger stones consist of volcanic rocks derived from Thirtymile Mile volcanic field and from Cripple Creek volcanic field. Thickness nearly 100 feet (30 m)

Permeability probably low. Excavation and compaction easy. Foundation stability good. Vertical cuts are stable for short time, then slump to slope of 40 degrees. Erosion checks probably required. Source of road metal or fill, but not of concrete aggregate

TKd DAWSON FORMATION (PALEOCENE AND UPPER CRETACEOUS)--White and yellowish-gray coarse sand, orange hard thin ironstone layers, and light-green claystone and siltstone. Thickness about 1,800 feet (548 m) northeast of quadrangle

Permeability probably medium in the arkosic sandstone and low in the siltstone and claystone. Formation produced water at Air Force Academy; availability of ground water is discussed by Cardwell and Jenkins (1967). Excavation is moderately difficult in unweathered claystone and siltstone and moderately difficult to difficult in the sandstone beds; blasting may be necessary in the cliff-forming arkosic sandstone. Compaction moderately difficult in the claystone and siltstone to very difficult in the sandstone. Foundation stability good in the sandstone, but probably poor in the claystone and siltstone, which may have low to high swelling properties. Some beds slake rapidly on exposure to air, and cutbanks should be poured soon after holes are drilled. Slope stability good in sandstone beds but poor in claystone and siltstone beds. Most beds, except hard sandstone, erode easily

Kl LARAMIE FORMATION (UPPER CRETACEOUS)--Dark-grayish-brown or yellowish-gray fine-grained iron-stained sandstone, olive-gray claystone, and subbituminous coal beds. Thickness about 250 feet (75 m)

Permeability medium. Formation is a good aquifer; availability of ground water discussed by Cardwell and Jenkins (1967). Excavation moderately difficult in the harder sandstone beds where rippers and the largest tracked vehicles or, locally, even blasting may be necessary. Compaction also difficult except in the softer more shaly beds. Foundation stability excellent on the sandstone beds but poor in the olive-gray claystone beds, which may have low to very high swelling potential. Slope stability good except in shaly and coaly beds. Resistance to erosion moderate to excellent. Source of coal and clay

Kf FOX HILLS SANDSTONE (UPPER CRETACEOUS)--Light olive-gray thin-bedded friable sandy shale in upper 100 feet (30 m) and olive-brown massive friable fine-grained sandstone in lower 150 feet (45 m). Contains phosphatic pebbles throughout. Thickness 250 feet (75 m) or more

Permeability medium. Formation is a good aquifer; availability of ground water discussed by Cardwell and Jenkins (1967). Excavation of sandstone moderately difficult; rippers and large tracked vehicles probably necessary. Compaction difficult if sandstone breaks in angular blocks. Foundation stability good to excellent. Slope stability good except in shale, which slumps somewhat from a vertical cut. Erosion resistance good

Kp PIERRE SHALE (UPPER CRETACEOUS)--Predominantly shaly beds containing bentonite beds. Upper part, clayey shale containing fibrous aragonite and cone-in-cone structure, underlain by dark-gray shaly sandstone above middle of formation. Underlain by clayey shale containing large irregular gray limestone masses that weather into conical mounds as high as 60 feet (18 m) called called tepee buttes. Underlain by soft shaly yellowish-brown sandstone below middle of formation. Underlain by silty noncalcareous shale containing ironstone nodules, then by a thin ridge-forming siltstone, then, at the base, by olive-gray clayey calcareous shale. Thickness 3,150-4,800 feet (960-1,463 m)

Permeability low. Excavation and compaction easy except for tepee buttes. Foundation stability poor; much of shale has low to very high swelling potential, especially the bentonite beds. Slope stability poor; vertical cuts may collapse. Shale in slopes no steeper than 5 degrees may slide, if toe of the slope is removed. Erosion resistance poor; check dams are necessary. Source of clay for brick and tile and of bloated clay for manufacture of light-weight aggregate

Kn NIOBRARA FORMATION (UPPER CRETACEOUS)

Smoky Hill Shale Member--Yellowish-brown soft thin-bedded calcareous shale and interbedded thinly layered limestone. Seven units from top to bottom: (1) yellowish-orange ridge-forming upper chalk unit; (2) yellowish-orange upper chalky shale unit; (3) yellowish-gray ridge-forming middle chalk or limestone unit; (4) dark-gray middle shale unit; (5) gray ridge-forming hard platy lower limestone unit; (6) dark-gray fissile to platy lower shale unit; and (7) gray shale and limestone unit. Thickness probably more than 530 feet (170 m)

Permeability low. Excavation fairly easy in shale, but moderately difficult in chalk and limestone beds. Small backhoe can excavate only with great difficulty lower limestone to a depth of 10 feet (3 m); the shale and limestone unit requires more powerful equipment. Compaction easy except where large blocks present. Foundation stability fairly good; however, the shale contains some swelling clay and bentonite beds. Slope stability good. Erosion resistance moderately poor; check dams probably needed. Potential source of cement rock and smelter limestone

Fort Hays Limestone Member--Gray hard limestone beds, 1-26 inches (2-65 cm) thick, separated by thin shaly partings. Thickness about 30-40 feet (9-12 m)

Permeability poor. Excavation and compaction difficult. Foundation stability excellent. Slope stability excellent, except on an undercut dip slope. Erosion resistance good. Source of cement rock and smelter limestone

Kcgg CARLILE SHALE, GREENHORN LIMESTONE, AND GRANEROS SHALE (UPPER CRETACEOUS)--Total thickness about 300 feet (90 m)

Carlile Shale--In descending order, Juana Lopez Member, grayish-brown hard calcarenite (sandy limestone composed of shell fragments) Codell Sandstone Member, yellowish-gray massive to thin-bedded sandstone; Blue Hill Shale Member, dark-gray noncalcareous shale containing large septarian concretions; Fairport Chalky Shale Member, yellowish-gray soft calcareous shale

Greenhorn Limestone--In descending order, Bridge Creek Limestone Member, gray dense limestone beds and gray hard calcareous shale; Hartland Shale Member, gray shaly calcarenite; Lincoln Limestone Member, grayish-brown thin beds of hard calcarenite and shaly calcarenite containing market bentonite at base

Graneros Shale--Dark-gray hard clayey shale

The Carlile, Greenhorn, and Graneros Formations share similar engineering properties as follows: permeability low except in the Codell. Excavation and compaction are moderately easy except in the Juana Lopez, Codell, and Bridge Creek Members, where difficult. Foundation stability fair to poor, and shale members have some swelling properties; however, the Juana Lopez, Codell, and Bridge Creek Members have excellent stability. Only the Juana Lopez, Codell, and Bridge Creek stand well in vertical cuts and resist erosion; all other units stable only in slopes of 5-10 degrees, or less, and erode readily

Kdp DAKOTA SANDSTONE AND PURGATOIRE FORMATION (LOWER CRETACEOUS)

Dakota Sandstone--Yellowish-brown fine-grained crossbedded sandstone containing some shale (Dry Creek Canyon Member) in upper middle part

Purgatoire Formation--Glencairn Shale Member, at top, contains shale, clay, and some gypsum; underlain by Lytle Sandstone Member, which contains fine- to coarse-grained sandstone and pebbly beds

Permeability is medium. Excavation difficult, and blasting may be required. Compaction difficult. Foundation stability excellent. Slope stability excellent except that rocks on dip slopes may slide if undercut. Erosion resistance excellent

Jmr MORRISON FORMATION AND RALSTON CREEK FORMATION (UPPER JURASSIC)

Morrison Formation--Variegated gray, maroon, and green siltstone and claystone and thin beds of sandstone, limestone, and conglomerate. Thickness 225 feet (68 m)

Ralston Creek Formation--Sandstone, siltstone, gypsum, and beds of limestone containing red jasper grains. Thickness 20 feet (6 m)

Permeability low. Excavation moderately difficult below a 5- to 10-foot (1.5-3 m) weathered zone. Compaction fairly easy. Foundation stability poor to fair. Slope stability moderately good. Erosion resistance fair; erosion checks probably needed

RPl LYKINS FORMATION (TRIASSIC? AND PERMIAN)--Maroon and green silty shale; white, maroon, and pink fine-grained sandstone, limestone, and gypsum. Thickness 180 feet (54 m)

Permeability low to medium. Excavation and compaction difficult to impossible for small power equipment such as a truck-mounted backhoe or a small tracked vehicle. Foundation stability good except on the gypsum. Slopes on most beds stand vertically for long time. Fairly resistant to erosion

Ply LYONS SANDSTONE (PERMIAN)--Red and yellowish-gray fine-grained sandstone consisting of resistant upper and lower ridge-forming units separated by less resistant sandstone, and locally conglomerate. Thickness 700-800 feet (210-240 m)

Permeability medium. Excavation and compaction difficult to impossible for small power equipment. Foundation stability excellent. Slope stability and erosion resistance excellent

PPf FOUNTAIN FORMATION (PERMIAN AND PENNSYLVANIAN)--Moderate reddish-brown arkosic conglomerate, yellowish-gray coarse-grained arkosic sandstone, and thin layers of pale-green and dark reddish-brown shale. Glen Eyrie Shale Member, at base, consists of gray sandstone, sandy shale, and black shale about 100 feet (30 m) thick. Thickness of formation 4,400 feet (1,320 m)

Permeability medium to low. Excavation and compaction very difficult to impossible for small power equipment. Foundation stability excellent. Slope stability and erosion resistance excellent

MCr MISSISSIPPIAN, DEVONIAN, ORDOVICIAN, AND CAMBRIAN ROCKS--Parts of this unit locally are mapped separately. Includes in descending order:

Leadville and Williams Canyon Limestone (Mississippian and Upper Devonian)--Both dark-gray hard dense limestones. Thickness about 130 feet (39 m)

Manitou Limestone (Lower Ordovician)--Reddish-gray thick- to thin-bedded or massive, dense or granular limestone, sherty in upper part. Limestone locally deformed by solution. Thickness about 185 feet (56 m)

Peerless Dolomite (Upper Cambrian)--Dark-red finely to coarsely crystalline granular glauconitic thin-bedded dolomite. Thickness about 40 feet (12 m)

Ꞓs Sawatch Sandstone (Upper Cambrian)--Reddish-brown, white, and green fine- to coarse-grained well-bedded sandstone. Glauconitic in upper part. Contains some dolomite beds. Thickness about 25 feet (7.5 m)

Engineering properties of Mississippian, Devonian, Ordovician, and Cambrian rocks similar. Permeability low except in solution cavities. Excavation and compaction difficult; blasting required. Foundation stability and slope stability excellent, except where solution has made caverns and loose breccia zones in limestone. Erosion resistance excellent. Leadville, Williams Canyon, Manitou, and Peerless Formations sources of crushed stone for use as concrete aggregate

PRECAMBRIAN ROCKS

Yfg Fayalite Granite (Precambrian Y)--Greenish-gray medium- to coarse-grained ferrohastingsite granite with minor fayalite altered to iddingsite. Forms dike(?) in Pikes Peak Granite southwest of Ormes Peak (Wobus, 1975)

Ywp Windy Point Granite (Precambrian Y)--Gray to pink finely crystalline porphyritic granite or quartz monzonite. Contains biotite in rounded clusters

Ypp Pikes Peak Granite (Precambrian Y)--Pink to reddish-tan medium to coarsely crystalline biotite or hornblende-biotite granite or quartz monzonite. Encloses many pegmatites that locally contain crystal-lined miarolitic cavities; weathers to coarse grus. Contains some gabbroic or diabasic dikes of Precambrian age

Xgnb Biotite Gneiss (Precambrian X)--Gray plagioclase-quartz-biotite gneiss. Locally contains muscovite, sillimanite, garnet; minor interlayers include hornblende gneiss and other variants

Although mapped separately, all Precambrian rocks share similar engineering properties

Permeability low to nonexistent except is medium to high along joints and other fractures, or where rocks are weathered, or in thin veneers of alluvium or colluvium. Weathered layer (grus) on Pikes Peak Granite locally exceeds 25 feet in thickness. Weathering in other units is thinner, especially in the Windy Point Granite. Excavation must be preceded by drilling and blasting, except that in the weathered zone excavation without recourse to explosives is easy to moderately difficult for small power equipment. Compaction probably difficult at most sites because of a lack of fines and because of large blocks. Foundation stability generally excellent except on steep slopes such as the canyon walls of Fountain Creek, where weathered Pikes Peak Granite is subject to landsliding. Slope stability and resistance to erosion excellent except in the deeply weathered grus. Potential flood hazard exists where dams are founded on weathered Pikes Peak Granite

CONTACT--Dotted where concealed; queried where location is uncertain

FAULT--U, upthrown side; D, downthrown side. Dotted where concealed; queried where sense of movement and amount of offset unknown

STRIKE AND DIP OF METAMORPHIC FOLIATION

STRIKE AND DIP OF BEDDING

Inclined

Vertical

*D2309 MESOZOIC INVERTEBRATE FOSSIL LOCALITY--Showing U.S.G.S. Denver catalog number. Fossils identified by W. A. Cobban

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