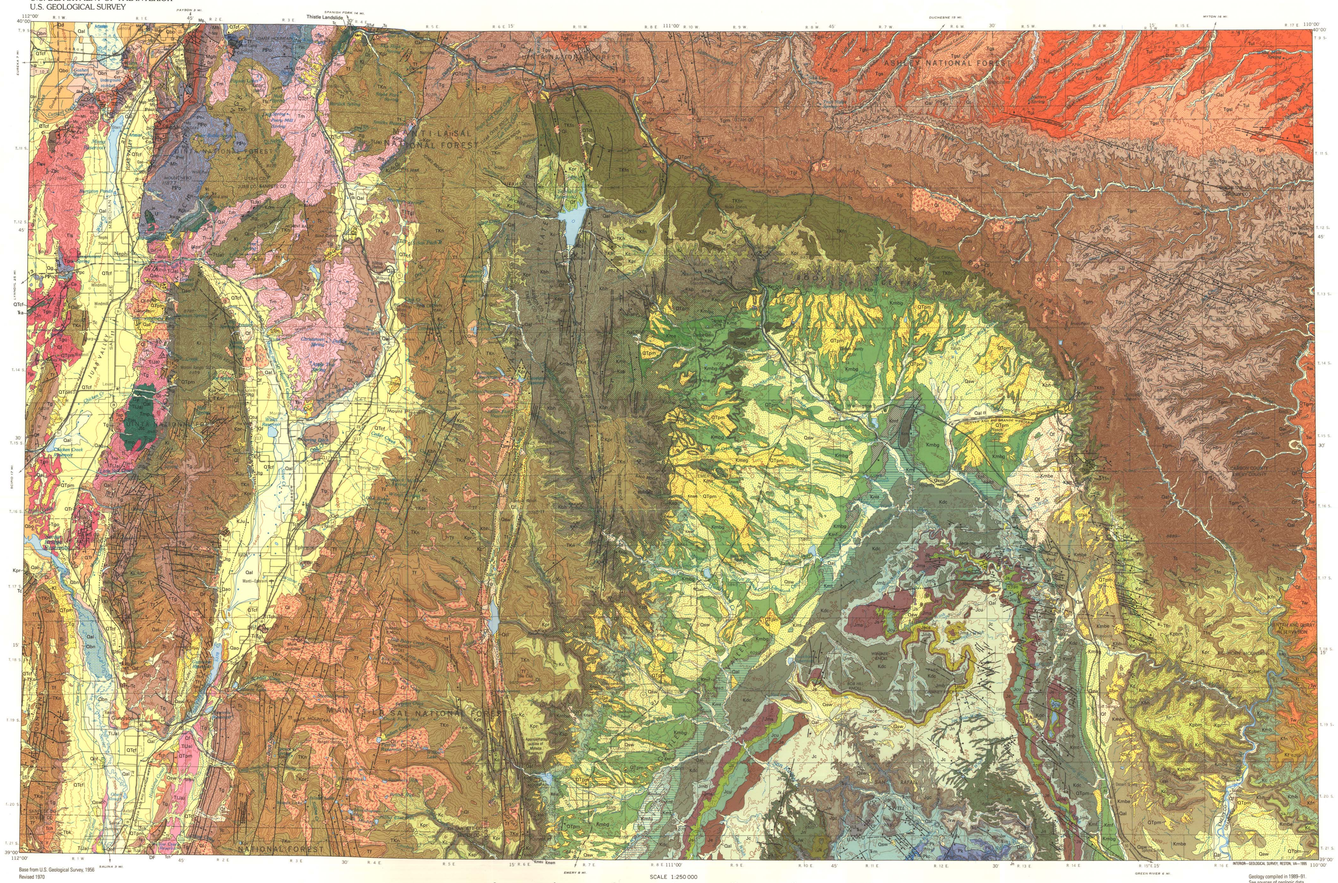
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-2462

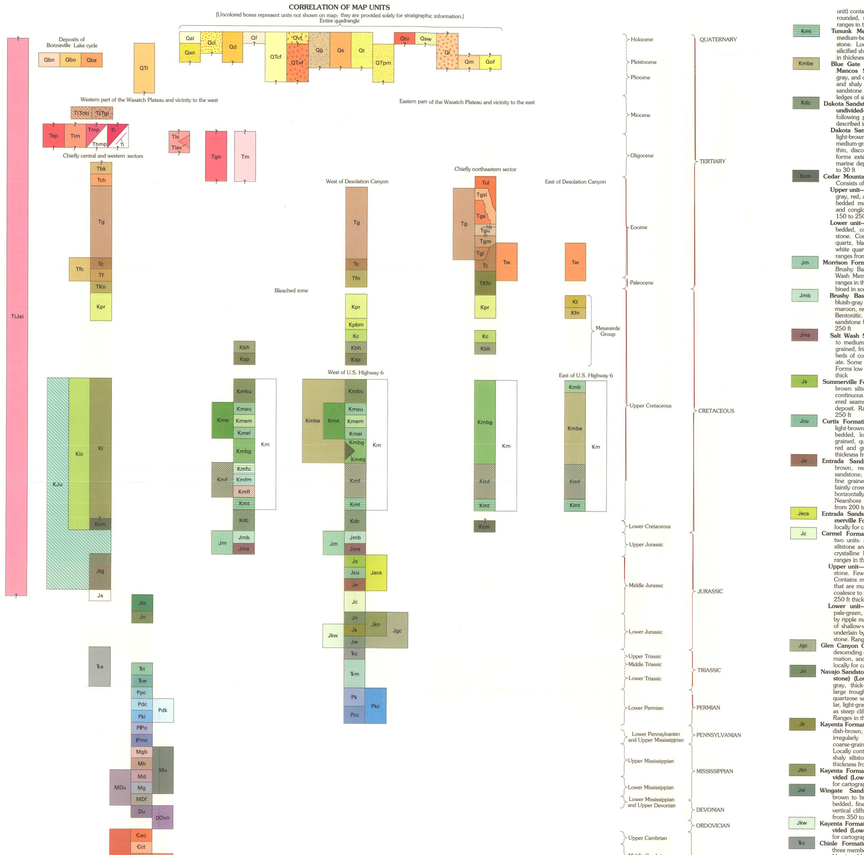


Geology compiled in 1969-81
See sources of geologic data

Edited by F. Craig Brunstein
Color design by Virginia D. Scott
Graphic design by Thomas L. Loesch
Cartography by Joseph A. Romero
Manuscript approved for publication January 5, 1994

CORRELATION OF MAP UNITS

[Uncolored boxes represent units not shown on map; they are provided solely for stratigraphic information.]



DESCRIPTION OF MAP UNITS

DESCRIPTION OF MAP UNITS

QUATERNARY

Quaternary and Tertiary deposits

Alluvium (Holocene)—Dark-brown to gray, thin to thick-bedded deposits of clay, silt, sand, granules, pebbles, and sparse cobbles. Unconsolidated. Formed by deposition on alluvial fans and broad areas. Thickness ranges widely, commonly less than 50 ft thick

Alluvial-fan deposits (Holocene)—Light-brown to brown, unconsolidated to semiconsolidated, poorly to moderately well sorted deposit of silt, sand, granules, pebbles, and cobbles that form lobate deposits at stream mouths. Chiefly siltstone and sandstone clasts. Thickness uncertain; probably as much as 50 ft locally

Valley-fill deposits (Holocene)—Light-brown to brown, unconsolidated, interbedded clay, silt, sand, and gravel. Composition of clasts reflects rocks exposed in adjacent hills. Thickness ranges from a few inches to 25 ft

Tufa deposit (Holocene)—Light-gray to light-tan, low, porous mound of calcium carbonate. Contains fine, soft, soft, cellular, porous layers. Deposit encrusts spring, that formed along a major high-angle fault that extends along the east front of the San Pitch Mountains (also known locally as the Gunnison Plateau). Thickness unknown, but likely not greater than 50 ft

Slope-wash deposits (Holocene)—Light- to dark-gray, thin- to thick-bedded deposits of clay, silt, sand, granules, and some pebbles. Faintly crosslabded. Unconsolidated to weakly cemented by calcium carbonate. Clasts, chiefly siltstone and sandstone, reflect formations exposed in adjacent hillslopes. Forms broad, gently sloping sheets. As much as 25 ft thick

Colluvium (Quaternary)—Brown to dark-brown heterogeneous mixture of fragments of sandstone, shale, and siltstone. Forms broad, gently sloping sheets. As much as 25 ft thick

Colluvium (Quaternary)—Brown to dark-brown heterogeneous mixture of fragments of sandstone, shale, and siltstone. Forms broad, gently sloping sheets. As much as 25 ft thick

Dune sand (Holocene)—Light-brown, unconsolidated, loose quartzose sand of eolian origin. Forms low dunes and ridges. Surface is bare to sparsely covered by vegetation. As much as 35 ft thick

Gravel deposits (Quaternary)—Light-brown, unconsolidated to semiconsolidated, thin- to thick-bedded, moderately well sorted alluvial deposits of clay, silt, sand, and gravel. In places, may include deposits formed during the Bonneville lake cycle

Silt deposits (Quaternary)—Light-brown, low, unconsolidated silt, marly sand, and minor clay, possibly of lacustrine origin, that is locally interbedded with pebble gravel. In places, probably deposited in shallow water during the Bonneville lake cycle. Possibly as much as 25 ft thick

Terrace deposits (Quaternary)—Light- to dark-brown, thin- to medium-bedded deposit of silt, sand, granules, pebbles, cobbles, and a few boulders. Locally crosslabded. Clasts, chiefly siltstone, sandstone, and limestone, are derived from bedrock exposed in source areas. Forms narrow terraces perhaps adjacent to and above major rivers and their tributaries. Ranges in thickness from about 10 ft to about 20 ft

Landslide deposits (Quaternary)—Brown to dark-brown and gray heterogeneous mixture of fragments, commonly angular, that range in size from silt to large boulders. Unit includes mainly slope-movement deposits such as earthflows, rock and debris slides, debris slumps, and large complex landslides undertaken by the North Fork Landslide. A few of the larger landslides exceed 200 ft in thickness. Most are less than a few hundred miles. Locally includes areas of colluvium, slope wash

Some of the large, complex landslides are scarred by small, distinctive earthflows and landslides. These younger flows and slides, such as the Manti landslide, are also labeled Ql

Older alluvium (Quaternary)—Much like alluvium (Qal) in color, bedding, and composition. Forms small, discrete, rounded to irregular masses of fluvial origin marked by even surface. Generally exposed 50 to 150 ft above adjacent valley floors. Ranges in thickness from about 10 to 200 ft

Moraine deposits (Pleistocene)—Brown to dark-brown masses of unsorted, unconsolidated to semiconsolidated glacial debris. Fragments range in size from clay to boulders as much as 6 ft in diameter. Characterized by lobate shape, morainal ridges, and locally by knob-and-kettle topography. Widespread south of the flower drainage in locally mapped as landslide deposits (Qls). Thickness as much as 200 ft

Older alluvial-fan deposits (Pleistocene)—Gray to dark gray, thin to thick-bedded deposits. Fan-shaped deposits are prominently crosshabded; unconsolidated. Consists of silt, sand, granules, pebbles, and cobbles. Includes small, thin interbedded lenses of crosshabded coarse sand. Mostly fluvial sediment. As much as 200 ft thick. Includes the "volcanic gravels" of Gilliland (1951, p. 53)

Rubble (Holocene to Pliocene?)—Light-brown to gray, angular, poorly sorted, unconsolidated to semiconsolidated, unbedded, well-compacted. Composed chiefly of deposits of Quaternary age, but may include some material as old as Oligocene. May be as much as 300 ft thick

Intrusive igneous rocks of the Levan area (John, 1972)

Syenodiorite porphyry (Pliocene to upper Oligocene)—Light-brown-gray syenodiorite porphyry locale near Levan. Phenocrysts (20 percent) of rock consist of hornblende (about 15 percent) and sanidine (about 5 percent). Accessory minerals are magnetite, apatite, and sphene. Groundmass is aphanitic and consists of sanidine, orthoclase, and hornblende

Monzonite (lower Miocene to upper Oligocene)—Light-gray to gray, fine-grained, slightly porphyritic monzonite intrusion. Phenocrysts (10 percent of rock) consist of plagioclase (oligoclase-andesine) (about 8 percent), hornblende (about 1 percent), and biotite (about 1 percent). Accessory minerals include plagioclase, hornblende, biotite, magnetite, apatite, sphene, zircon, orthoclase, and sparse quartz

Monzonite porphyry and quartz monzonite porphyry (Oligocene)—Gray, fine- to medium-grained, monzonite porphyry. Phenocrysts (32 percent of rock) consist of plagioclase (oligoclase-andesine) (about 20 percent), hornblende (about 10 percent), and biotite (about 2 percent). Accessory minerals consist of apatite, magnetite, sphene, and zircon. Groundmass consists of plagioclase, orthoclase, and sparse quartz.

Hornblende monzonite porphyry (lower Miocene to upper Oligocene)—Essentially similar to monzonite porphyry in granitic texture, but with the major exception that this unit is very rich in hornblende. Phenocrysts (40 percent)

Intrusive rocks (lower Miocene to upper Oligocene)—Small dikes, sills, and rounded bosses of differing composition. Most are exposed between Levan and consist of intermediate-composition rocks such as diabase, andesite, and monzonite (John, 1972). Includes latite dikes and sills in the Gap, in Sevier Valley, ranging from 30 to 50 ft in thickness; may be as much as 250 ft thick elsewhere

Offshore deposits (upper Pleistocene)—Light-gray to gray, well-sorted, well-compacted deposits of silt, clay, and minor sand. Lacustrine origin. Thickness unknown

Shoreline deposits (upper Pleistocene)—Light-gray generally well-sorted, even-bedded sand and gravel deposits that form deltas, spits, and bars along the shoreline of former Lake Bonneville. Locally as much as 75 ft thick

WESTERN PART OF WASATCH PLATEAU AND VICINITY TO THE WEST

Depositic intrusions

Intrusive masses of Arapien Shale (Quaternary?) to Middle Jurassic—Generally light-gray, poorly sorted, poorly well-sorted, even-bedded sand and gravel deposits that form deltas, spits, and bars along the shoreline of former Lake Bonneville. Locally as much as 75 ft thick

Extrusive igneous rocks and their products

(chiefly western part)

Lagoon Springs Volcanic Group (Oligocene)—Chiefly latite and andesite lava flows with interbedded volcanic lava flows and volcanic mudflow breccia. Thickness uncertain; probably as much as 1,000 ft

Main body—Tuff is light gray to dark gray, fine to coarse grained, and contains small to large fragments of sedimentary and igneous rock. Flows are dark gray and coarsely porphyritic. Breccia is predominantly, it is mapped as a separate unit (Tbv). Thickness unknown

Volcanic mudflow breccia—Dark to brownish-gray, locally reddish-gray, thick-bedded to massive breccia consisting of a heterogeneous mixture of clasts of latite, andesite, and quartzite. Fragments of dark-gray andesite, latite, quartzite, and some blocks of sedimentary rock enclosed in fine-grained, reddish-brown to brownish-gray matrix with boulders. Thickness unknown

Gordon Peak Formation (middle Oligocene to upper Eocene)—Volcaniclastic and pyroclastic rocks, including tuff, tuff breccia, and minor stream-deposited conglomerate and sandstone. Dominant rock unit is a light-gray to gray conglomeratic sandstone containing rounded andesite, latite, quartzite, and limestone clasts. Tuff is light gray to light brown and contains sparse andesite and quartzite clasts. Tuff breccia is light brown and a few interbedded lava flows. Sage Valley Limestone Member is light gray, fine grained, and about 100 ft thick; contains plant remains, Goldeneyes Ranch Formation intertongues with Gordon Peak, associated with Lagoon Springs Volcanic Group (Tbl) (Morris and Lovering, 1961, p. 126). Thickness unknown; at least 1,000 ft thick. Age relates with the Morrel Formation (Tmf) (Witkind and Marvin, 1989, p. 544)

Morrel Formation (middle Oligocene to upper Eocene)—Volcaniclastic and pyroclastic rocks, including ash-flow and welded tuff and stream-deposited conglomerate and sandstone. Tuff commonly porous and friable, but locally includes lightgray, densely welded, vitric tuff and greenish-gray crystal, lithic, and welded tuff containing rounded andesite clasts. Abundant fragments of quartz, albite, biotite, and hornblende. Fragments of pumice in ash-flow tuff. Conglomerate is light gray, poorly sorted, and commonly poorly sorted, contains volcanic cobbles and pebbles and well-rounded classes of quartz and maroon quartzite and dark-blue limestone. Probably correlates with the Goldens Ranch Formation (Witkind and Marvin, 1989, p. 544). Thickness ranges greatly throughout the area; maximum thickness is about 2,000 ft (Cooper, 1956)

Tertiary sedimentary rocks

Bald Knoll Formation of Gilliland (1951) (lower Oligocene or upper Eocene?)—Light-gray to tan mudstone, claystone, and interbedded siltstone, sandstone, and a few thin, dense, finely crystalline limestone beds. Locally limestone is soft. Fresh-water to brackish deposit. Probably ranges in thickness from about 800 to 1,000 ft

Recent work by Willis (1986) has suggested that the Bald Knoll section as described in the section are not correlative with other rocks mapped as Bald Knoll Formation in Sevier Valley. Pending resolution of this problem, Willis (1986) uses the term "Sevier Valley" for the units here mapped as the Bald Knoll Formation of Gilliland (1951), and he assigned it an Eocene age

Crazy Hollow Formation (Eocene)—Red- to reddish-brown, light-yellow-brown, and locally white sandstone, shale, siltstone, and some conglomerate. In a few places locally, gray to light-gray limestone, black, thin, dense limestone beds. Salt-and-pepper sandstone at base. Conglomerate contains distinctive black, well-rounded chert pebbles. Fluvial deposit. Thickness ranges from about 1,000 ft to about 2,000 ft

Green River Formation (Eocene)—Consists of a lime-stone unit underlain by a shale unit. In the Sanpitch River origin. Thickness of formation ranges widely, from about 500 to 2,000 ft

Limestone unit—Pale-yellowish-gray to yellow-brown to light-brown, thin to medium-bedded, even-bedded limestone and minor thin units of bedded sandstone and tuff. Limestone is dense, finely crystalline, and commonly oolitic; some thin limestone beds are microbreccia and rich in ostracodes. Forms resistant ledges and low cliffs

Shale unit—Light-gray to light-green, thin-bedded shale, subordinate calcareous shale and sparse interbedded limestone. Forms gentle slopes

Tbk **Colton Formation (Eocene)**—Variegated in shades of reddish brown, light gray, or light green, fine-grained. Commonly claystone and mudstone; locally includes beds of yellowish-gray sandstone, brown siltstone and sandstone, and reddish-brown conglomerate. Chiefly of alluvial origin; residual in parts of Angelica Canyon and Ephraim Canyon. Thickness ranges from about 1,000 ft to about 2,000 ft

Flagstaff Limestone (Eocene and Paleocene)—Light-gray to yellowish-gray and light-brown, thin- to massive-bedded limestone. Thin to thick bedded, massive in places; fine grained, dense, and finely crystalline. Contains subordinate interbedded dark-gray, gray, and brown-gray shale. Occasional thin sandstone beds locally abundant. Fresh-water lacustrine deposit. Thickness ranges from about 1,000 ft

Flagstaff Limestone and Colton Formation, undivided (Eocene and Paleocene)—Units combined locally for cartographic purposes

Tertiary and Mesozoic sedimentary rocks

North Horn Formation (Paleocene and Upper Cretaceous)—Reddish-brown to brown mudstone, claystone, sandstone, conglomerate, and sparse limestone; units alternate irregularly. Mudstone is reddish-brown to maroon; sandstone is fine to medium grained, ranges from thin to thick bedded, and is commonly cross-bedded. Limestone beds are thin, dense, and finely crystalline. Conglomerate is mostly in lenses along east flank of Gunnison Plateau and Wales, Chiefly fluvial deposits. Unstable, marked by many landslides. Ranges in thickness from about 500 to 3,000 ft

Mesozoic sedimentary rocks

Kpr **Price River Formation (Upper Cretaceous)**—Gray to light-gray conglomerate, coarse-grained sandstone, sandstone, and minor shale. Thin to thick bedded; locally massive; commonly cross-bedded. Coarse conglomerate contains well-rounded clasts of white quartzite, green quartzite, black chert, light-gray and black chert, and sparse dark-red quartzite. Sandstone is light gray, medium grained. Fluvial deposit; clasts chiefly of conglomerate beds that probably contain equivalents of Castlegate Sandstone. Ranges in thickness to 1,200 ft.

Ksl **Indianola Group (Upper Cretaceous)**

West of Sanpete Valley—Light-brown and gray, thick-bedded to massive, well-cemented conglomerate. Consists of sand, granules, pebbles, and well-rounded cobbles of white, purple, green, gray, light-green, and light-brown quartzite; light-brown to light-gray chert, white quartz, and gray to dark-blue limestone. Fluvial deposit; clasts derived from Paleozoic Rocks and Jurassic and Triassic Rocks. Ranges in thickness from 0 to 1,000 ft; Spieker, 1949, p. 13)

East of Sanpete Valley—Light-brown to yellowish-brown sandstone, shale, coal, and some conglomerate. Chiefly marine deposits. Includes the following four named units (in descending order): Storrie Canyon Formation (sandstone, coal, and minor conglomerate), Funk Valley Formation (sandstone and shale), Allen Valley Tongue (marine shale), and Sanpete Formation (sandstone). About 2,250 ft thick

Kcd **Cedar Mountain Formation (Lower Cretaceous)**—Variegated orange, purple, red, gray, and green massive to thick-bedded mudstone. Contains sparse, interbedded, discontinuous thin beds of conglomerate, sandstone, and freshwater limestone. Commonly characterized by abundant light-gray limestone nodules. Unstable; subject to landslides. Thickness ranges from about 60 to 1,400 ft

Kbc **Indianola Group and Cedar Mountain Formation, undivided (Upper and Lower Cretaceous)**—Units combined locally for cartographic purposes

Cretaceous and Jurassic strata, undivided—Include Indianola Group (Kin), Cedar Mountain Formation (Kcd), Morrison Formation (Jm), Curtis (Jc), Entrada (Je), and Navajo (Jn) Sandstones

Dakota Sandstone and Cedar Mountain Formation, undivided—Dakota Sandstone described in the following paragraph. Cedar Mountain Formation described in the following unit description

Dakota Sandstone (Upper Cretaceous)—Tan to light-brown, thin-bedded, crossbedded, fine- to medium-grained quartzose sandstone. Contains thin, discontinuous carbonaceous seams. Locally forms extensive dip slopes. Beach to marginal-marine deposit; deltaic. Thickness ranges from 0 to 50 ft

Cedar Mountain Formation (Lower Cretaceous)—Consists of two units

Upper unit—Variegated in shades of orange, purple, gray, red, and green; dominantly massive to thick-bedded mudstone. Few discontinuous sandstone and conglomerate lenses. Thickness ranges from 150 to 250 ft

Lower unit—Gray, massive to thick-bedded, crossbedded, conglomerate and conglomeratic sandstone. Consists of well-rounded clasts of white quartz, black, brown, and light-gray chert, and white quartzite. Forms resistant ledge. Thickness ranges from 10 to 80 ft

Morrison Formation (Upper Jurassic)—Consists of Brushy Basin Member (Jmb) underlain by Salt Wash Member (Jms). Fluvial deposit. Formation ranges in thickness from 350 to 400 ft. Units combined in some areas for cartographic purposes

Brushy Basin Member—Variegated, dominantly shale-gray and gray with bands of yellow, green, and red. Contains abundant bentonitic mudstone. Bentonitic. Contains a few thin limestone and sandstone beds. Ranges in thickness from 150 to 250 ft

Salt Wash Sandstone Member—Light-gray, thin- to medium-bedded, crossbedded, fine- to coarse-grained, friable, quartzose sandstone and lenticular beds of conglomeratic sandstone and conglomerate. Some interbedded gray and purple mudstone. Forms low cliffs and rounded ledges. About 180 ft thick

Summerville Formation (Middle Jurassic)—Reddish-brown siltstone and sandstone. Thin, even, and continuous bedding is characteristic. Many interlayered seams and thin beds of gypsum. Total 120 to 250 ft. Ranges in thickness from about 120 to 250 ft

Curtis Formation (Middle Jurassic)—Light-gray to light-brown and greenish-gray, thin- to medium-bedded, locally crossbedded, fine- to medium-grained, quartzose sandstone. Some interbedded red and gray shale. Marine deposit. Ranges in thickness from 75 to 250 ft

Entrada Sandstone (Middle Jurassic)—Orange-brown, reddish-brown, and locally light-brown sandstone; medium to thick bedded; dominantly fine grained, locally medium to coarse grained, faintly crossbedded; friable. Forms rounded ledges, horizontally grooved low cliffs, and steep slopes. Nearshore eolian deposit. Ranges in thickness from 200 to 300 ft

Entrada Sandstone, Curtis Formation, and Summerville Formation, undivided—Units combined locally for cartographic purposes

Carmel Formation (Middle Jurassic)—Consists of two units, a lower unit of reddish-brown shaly siltstone and a upper unit of light-gray, fossil-rich crystalline limestone. Marine deposit. Formation ranges in thickness from 280 to 350 ft

Upper unit—Reddish-brown, thin-bedded, shaly siltstone. Few thin sandstone beds in upper part. Contains many small lenses and beds of gypsum that are much contorted in places and that locally coalesce to form beds about 25 ft thick. Unit about 250 ft thick

Lower unit—Light-gray to brownish-gray, locally pale-green, thin-bedded, dense limestone. Marked by ripple marks, raindrop pits, and other evidence of shallow-water deposition. Fossiliferous. Locally underlain by a thin bed of reddish-brown shaly siltstone. Ranges in thickness from 30 to 50 ft

Glen Canyon Group (Lower Jurassic)—Includes, in ascending order, Navajo Sandstone, Kayenta Formation, and Wingate Sandstone. Units combined locally for cartographic purposes

Navajo Sandstone (also known as the Nugget Sandstone) (Lower Jurassic)—Light-brown to light-gray, thick-bedded to massive, crossbedded in large trough sets, fine-grained, clean and friable quartzose sandstone. Contains a few thin, lenticular, light-gray limestone beds in upper part. Stands as steep cliffs and rounded knolls. Eolian deposit. Ranges in thickness from 600 to 1,000 ft

Kayenta Formation (Lower Jurassic)—Lavender, red-dish-brown, and pale-red, thin- to medium-bedded, irregularly bedded and crossbedded, fine- to coarse-grained sandstone. Some shaly siltstone. Locally contains a few conglomerate lenses rich in chert pebbles. Fluvial deposit. Ranges in thickness from 100 to 250 ft

Wingate Sandstone (Lower Jurassic)—Reddish-brown to brown, thick-bedded to massive, crossbedded, fine-grained quartzose sandstone. Forms vertical cliffs. Eolian deposit. Ranges in thickness from 350 to 450 ft

Kayenta Formation and Wingate Sandstone, undivided (Lower Jurassic)—Units combined locally for cartographic purposes

Chinle Formation (Upper Triassic)—Divisible into three members (in descending order): Church Rock Member, Moss Back Member, and Temple Mountain Member. Units combined for cartographic purposes

Church Rock Member—Reddish-brown to dark-brown, locally light-gray and gray, thin- to medium-bedded sandstone and shaly siltstone. Lenticular. Ranges in thickness from 150 to 175 ft

Moss Back Member—Light-gray to gray, thin- to medium-bedded, crossbedded sandstone, conglomeratic sandstone, and some conglomerate. Minor interbedded mudstone. Consists chiefly of granules and pebbles of quartz, quartzite, and chert in a well-cemented matrix of medium to coarse sand. Contains abundant fossil wood. Fluvial deposit. Formerly, this unit mapped as the Shinarump Conglomerate (Gilluly, 1929, pl. 30)

Temple Mountain Member—In places, lowermost until contains many very large, 5-8 ft in diameter, rounded, sandstone concretions. The lower unit ranges in thickness from about 10 to 40 ft

Tumunk Member—Light- to dark-gray, thin- to medium-bedded, even-bedded shale and shaly siltstone. Locally contains discontinuous ledges of silicified shale. Few sandstone concretions. Ranges in thickness from about 0 to 100 ft

Blue Gate and Emery Sandstone Members of Mancos Shale, undivided—Light-gray, bluish-gray, and dark-gray, thin- to medium-bedded shale and shaly siltstone. Few thin interlayered brown sandstone beds. Includes sparse discontinuous ledges of silicified shale. About 3,500 ft thick

Dakota Sandstone and Cedar Mountain Formation, undivided—Dakota Sandstone described in the following paragraph. Cedar Mountain Formation described in the following unit description

Dakota Sandstone (Upper Cretaceous)—Tan to light-brown, thin-bedded, crossbedded, fine- to medium-grained quartzose sandstone. Contains thin, discontinuous carbonaceous seams. Locally forms extensive dip slopes. Beach to marginal-marine deposit; deltaic. Thickness ranges from 0 to 50 ft

Cedar Mountain Formation (Lower Cretaceous)—Consists of two units

Upper unit—Variegated in shades of orange, purple, gray, red, and green; dominantly massive to thick-bedded mudstone. Few discontinuous sandstone and conglomerate lenses. Thickness ranges from 150 to 250 ft

Lower unit—Gray, massive to thick-bedded, crossbedded, conglomerate and conglomeratic sandstone. Consists of well-rounded clasts of white quartz, black, brown, and light-gray chert, and white quartzite. Forms resistant ledge. Thickness ranges from 10 to 80 ft

Morrison Formation (Upper Jurassic)—Consists of Brushy Basin Member (Jmb) underlain by Salt Wash Member (Jms). Fluvial deposit. Formation ranges in thickness from 350 to 400 ft. Units combined in some areas for cartographic purposes

Brushy Basin Member—Variegated, dominantly shale-gray and gray with bands of yellow, green, and red. Contains abundant bentonitic mudstone. Bentonitic. Contains a few thin limestone and sandstone beds. Ranges in thickness from 150 to 250 ft

Salt Wash Sandstone Member—Light-gray, thin- to medium-bedded, crossbedded, fine- to coarse-grained, friable, quartzose sandstone and lenticular beds of conglomeratic sandstone and conglomerate. Some interbedded gray and purple mudstone. Forms low cliffs and rounded ledges. About 180 ft thick

Summerville Formation (Middle Jurassic)—Reddish-brown siltstone and sandstone. Thin, even, and continuous bedding is characteristic. Many interlayered seams and thin beds of gypsum. Total 120 to 250 ft. Ranges in thickness from about 120 to 250 ft

Curtis Formation (Middle Jurassic)—Light-gray to light-brown and greenish-gray, thin- to medium-bedded, locally crossbedded, fine- to medium-grained, quartzose sandstone. Some interbedded red and gray shale. Marine deposit. Ranges in thickness from 75 to 250 ft

Entrada Sandstone (Middle Jurassic)—Orange-brown, reddish-brown, and locally light-brown sandstone; medium to thick bedded; dominantly fine grained, locally medium to coarse grained, faintly crossbedded; friable. Forms rounded ledges, horizontally grooved low cliffs, and steep slopes. Nearshore eolian deposit. Ranges in thickness from 200 to 300 ft

Entrada Sandstone, Curtis Formation, and Summerville Formation, undivided—Units combined locally for cartographic purposes

Carmel Formation (Middle Jurassic)—Consists of two units, a lower unit of reddish-brown shaly siltstone and a upper unit of light-gray, fossil-rich crystalline limestone. Marine deposit. Formation ranges in thickness from 280 to 350 ft

Upper unit—Reddish-brown, thin-bedded, shaly siltstone. Few thin sandstone beds in upper part. Contains many small lenses and beds of gypsum that are much contorted in places and that locally coalesce to form beds about 25 ft thick. Unit about 250 ft thick

Lower unit—Light-gray to brownish-gray, locally pale-green, thin-bedded, dense limestone. Marked by ripple marks, raindrop pits, and other evidence of shallow-water deposition. Fossiliferous. Locally underlain by a thin bed of reddish-brown shaly siltstone. Ranges in thickness from 30 to 50 ft

Glen Canyon Group (Lower Jurassic)—Includes, in ascending order, Navajo Sandstone, Kayenta Formation, and Wingate Sandstone. Units combined locally for cartographic purposes

Navajo Sandstone (also known as the Nugget Sandstone) (Lower Jurassic)—Light-brown to light-gray, thick-bedded to massive, crossbedded in large trough sets, fine-grained, clean and friable quartzose sandstone. Contains a few thin, lenticular, light-gray limestone beds in upper part. Stands as steep cliffs and rounded knolls. Eolian deposit. Ranges in thickness from 600 to 1,000 ft

Kayenta Formation (Lower Jurassic)—Lavender, red-dish-brown, and pale-red, thin- to medium-bedded, irregularly bedded and crossbedded, fine- to coarse-grained sandstone. Some shaly siltstone. Locally contains a few conglomerate lenses rich in chert pebbles. Fluvial deposit. Ranges in thickness from 100 to 250 ft

Wingate Sandstone (Lower Jurassic)—Reddish-brown to brown, thick-bedded to massive, crossbedded, fine-grained quartzose sandstone. Forms vertical cliffs. Eolian deposit. Ranges in thickness from 350 to 450 ft

Kayenta Formation and Wingate Sandstone, undivided (Lower Jurassic)—Units combined locally for cartographic purposes

Chinle Formation (Upper Triassic)—Divisible into three members (in descending order): Church Rock Member, Moss Back Member, and Temple Mountain Member. Units combined for cartographic purposes

Church Rock Member—Reddish-brown to dark-brown, locally light-gray and gray, thin- to medium-bedded sandstone and shaly siltstone. Lenticular. Ranges in thickness from 150 to 175 ft

Moss Back Member—Light-gray to gray, thin- to medium-bedded, crossbedded sandstone, conglomeratic sandstone, and some conglomerate. Minor interbedded mudstone. Consists chiefly of granules and pebbles of quartz, quartzite, and chert in a well-cemented matrix of medium to coarse sand. Contains abundant fossil wood. Fluvial deposit. Formerly, this unit mapped as the Shinarump Conglomerate (Gilluly, 1929, pl. 30)

Temple Mountain Member—In places, lowermost until contains many very large, 5-8 ft in diameter, rounded, sandstone concretions. The lower unit ranges in thickness from about 10 to 40 ft

Tumunk Member—Light- to dark-gray, thin- to medium-bedded, even-bedded shale and shaly siltstone. Locally contains discontinuous ledges of silicified shale. Few sandstone concretions. Ranges in thickness from about 0 to 100 ft

Blue Gate and Emery Sandstone Members of Mancos Shale, undivided—Light-gray, bluish-gray, and dark-gray, thin- to medium-bedded shale and shaly siltstone. Few thin interlayered brown sandstone beds. Includes sparse discontinuous ledges of silicified shale. About 3,500 ft thick

Kdc **Dakota Sandstone and Cedar Mountain Formation, undivided**—Dakota Sandstone described in the following paragraph. Cedar Mountain Formation described in the following unit description

Dakota Sandstone (Upper Cretaceous)—Tan to light-brown, thin-bedded, crossbedded, fine- to medium-grained quartzose sandstone. Contains thin, discontinuous carbonaceous seams. Locally forms extensive dip slopes. Beach to marginal-marine deposit; deltaic. Thickness ranges from 0 to 50 ft

Kcm **Cedar Mountain Formation (Lower Cretaceous)**—Consists of two units

Upper unit—Variegated in shades of orange, purple, gray, red, and green; dominantly massive to thick-bedded mudstone. Few discontinuous sandstone and conglomerate lenses. Thickness ranges from 150 to 250 ft

Lower unit—Gray, massive to thick-bedded, crossbedded, conglomerate and conglomeratic sandstone. Consists of well-rounded clasts of white quartz, black, brown, and light-gray chert, and white quartzite. Forms resistant ledge. Thickness ranges from 10 to 80 ft

Jm **Morrison Formation (Upper Jurassic)**—Consists of Brushy Basin Member (Jmb) underlain by Salt Wash Member (Jms). Fluvial deposit. Formation ranges in thickness from 350 to 400 ft. Units combined in some areas for cartographic purposes

Brushy Basin Member—Variegated, dominantly shale-gray and gray with bands of yellow, green, and red. Contains abundant bentonitic mudstone. Bentonitic. Contains a few thin limestone and sandstone beds. Ranges in thickness from 150 to 250 ft

Salt Wash Sandstone Member—Light-gray, thin- to medium-bedded, crossbedded, fine- to coarse-grained, friable, quartzose sandstone and lenticular beds of conglomeratic sandstone and conglomerate. Some interbedded gray and purple mudstone. Forms low cliffs and rounded ledges. About 180 ft thick

Js **Summerville Formation (Middle Jurassic)**—Reddish-brown siltstone and sandstone. Thin, even, and continuous bedding is characteristic. Many interlayered seams and thin beds of gypsum. Total 120 to 250 ft. Ranges in thickness from about 120 to 250 ft

Jcu **Curtis Formation (Middle Jurassic)**—Light-gray to light-brown and greenish-gray, thin- to medium-bedded, locally crossbedded, fine- to medium-grained, quartzose sandstone. Some interbedded red and gray shale. Marine deposit. Ranges in thickness from 75 to 250 ft

Je **Entrada Sandstone (Middle Jurassic)**—Orange-brown, reddish-brown, and locally light-brown sandstone; medium to thick bedded; dominantly fine grained, locally medium to coarse grained, faintly crossbedded; friable. Forms rounded ledges, horizontally grooved low cliffs, and steep slopes. Nearshore eolian deposit. Ranges in thickness from 200 to 300 ft

Jecs **Entrada Sandstone, Curtis Formation, and Summerville Formation, undivided**—Units combined locally for cartographic purposes

Jc **Carmel Formation (Middle Jurassic)**—Consists of two units, a lower unit of reddish-brown shaly siltstone and a upper unit of light-gray, fossil-rich crystalline limestone. Marine deposit. Formation ranges in thickness from 280 to 350 ft

Upper unit—Reddish-brown, thin-bedded, shaly siltstone. Few thin sandstone beds in upper part. Contains many small lenses and beds of gypsum that are much contorted in places and that locally coalesce to form beds about 25 ft thick. Unit about 250 ft thick

Lower unit—Light-gray to brownish-gray, locally pale-green, thin-bedded, dense limestone. Marked by ripple marks, raindrop pits, and other evidence of shallow-water deposition. Fossiliferous. Locally underlain by a thin bed of reddish-brown shaly siltstone. Ranges in thickness from 30 to 50 ft

Jgc **Glen Canyon Group (Lower Jurassic)**—Includes, in ascending order, Navajo Sandstone, Kayenta Formation, and Wingate Sandstone. Units combined locally for cartographic purposes

Jn **Navajo Sandstone (also known as the Nugget Sandstone) (Lower Jurassic)**—Light-brown to light-gray, thick-bedded to massive, crossbedded in large trough sets, fine-grained, clean and friable quartzose sandstone. Contains a few thin, lenticular, light-gray limestone beds in upper part. Stands as steep cliffs and rounded knolls. Eolian deposit. Ranges in thickness from 600 to 1,000 ft

Jk **Kayenta Formation (Lower Jurassic)**—Lavender, red-dish-brown, and pale-red, thin- to medium-bedded, irregularly bedded and crossbedded, fine- to coarse-grained sandstone. Some shaly siltstone. Locally contains a few conglomerate lenses rich in chert pebbles. Fluvial deposit. Ranges in thickness from 100 to 250 ft

Jw **Wingate Sandstone (Lower Jurassic)**—Reddish-brown to brown, thick-bedded to massive, crossbedded, fine-grained quartzose sandstone. Forms vertical cliffs. Eolian deposit. Ranges in thickness from 350 to 450 ft

Jkw **Kayenta Formation and Wingate Sandstone, undivided (Lower Jurassic)**—Units combined locally for cartographic purposes

TRc **Chinle Formation (Upper Triassic)**—Divisible into three members (in descending order): Church Rock Member, Moss Back Member, and Temple Mountain Member. Units combined for cartographic purposes

Church Rock Member—Reddish-brown to dark-brown, locally light-gray and gray, thin- to medium-bedded sandstone and shaly siltstone. Lenticular. Ranges in thickness from 150 to 175 ft

Moss Back Member—Light-gray to gray, thin- to medium-bedded, crossbedded sandstone, conglomeratic sandstone, and some conglomerate. Minor interbedded mudstone. Consists chiefly of granules and pebbles of quartz, quartzite, and chert in a well-cemented matrix of medium to coarse sand. Contains abundant fossil wood. Fluvial deposit. Formerly, this unit mapped as the Shinarump Conglomerate (Gilluly, 1929, pl. 30)

Temple Mountain Member—In places, lowermost bedded. Undivided strata crop out as irregularly alternating resistant and nonresistant beds. Thickness ranges from 200 to 1,100 ft

Mesozoic rocks

Mesaverde Group (Upper Cretaceous)—Consists of Price River Formation, Castlegate Sandstone, and a series of units that grade into one another but differ sufficiently to warrant separate mapping in both west and east of Desolation Canyon

West of Desolation Canyon—Includes Price River Formation, Blackhawk Formation, Spring Canyon Member, and mudstone member of the Price River Formation. Units combined in the Castlegate Sandstone, Black-hawk Formation, and Star Point Sandstone

East of Desolation Canyon—Includes Tavaputs Farmer, and Neslen Formations

Kpr **Price River Formation (Upper Cretaceous)**—Gray to light-gray conglomerate, conglomeratic sandstone, sandstone, and minor shale. Thin to thick-bedded; locally massive; commonly well cemented. Coarse conglomerate contains well-rounded clasts of light-brown and purple quartzite, light-gray and black chert, and sparse dark-red quartzite. Sandstone is light gray, medium grained. Fluvial deposit; clasts chiefly of conglomerate beds that probably contain equivalents of Castlegate Sandstone. Ranges in thickness from 0 to 1,200 ft.

Kbh **Blackhawk Formation (Upper Cretaceous)**—Dominantly light-brown, locally brown