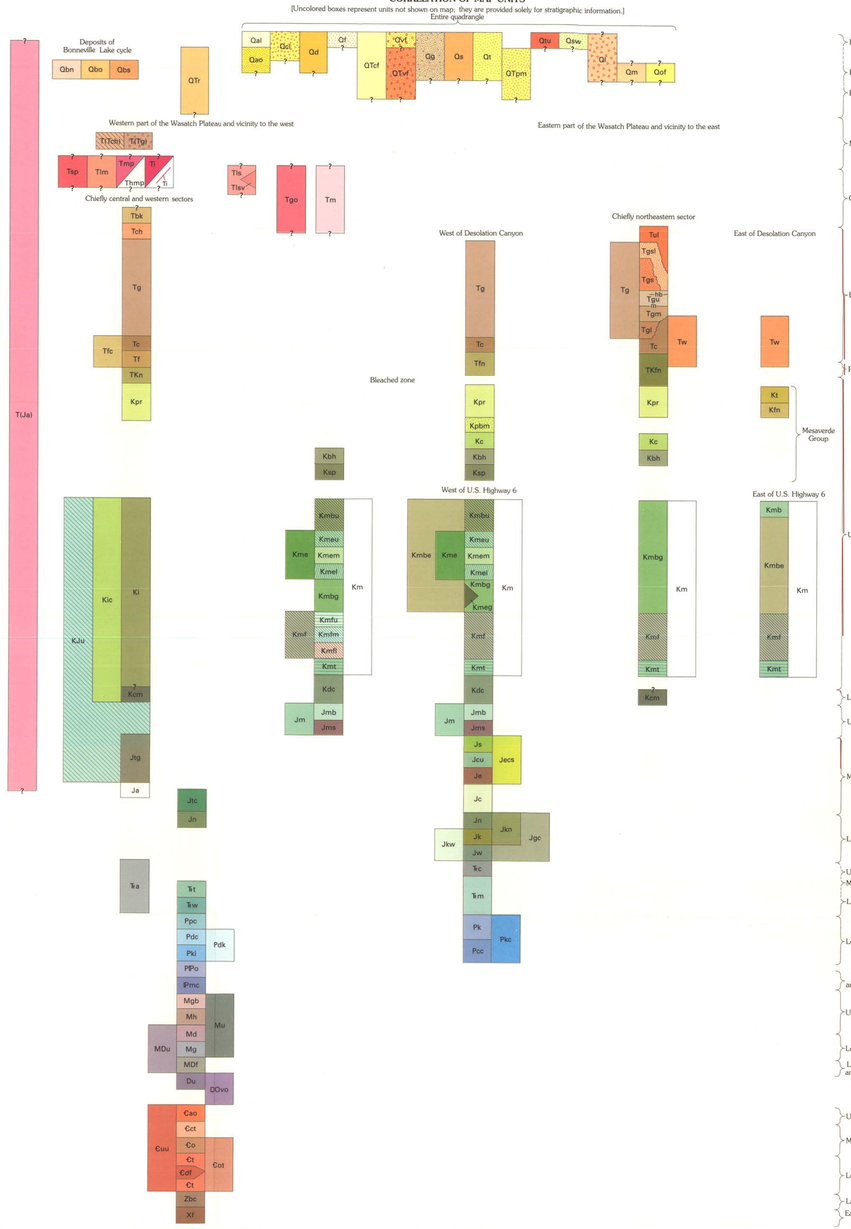
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-2462

CORRELATION OF MAP UNITS

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



DESCRIPTION OF MAP UNITS

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QUATERNARY

Quaternary and Tertiary deposits

Qal Alluvium (Holocene)—Dark-brown to gray, thin to thick-bedded deposits of clay, silt, sand, granules, pebbles, and sparse cobbles. Unconsolidated. Forms broad, level surfaces along modern streams. Thickness ranges widely; commonly less than 50 ft thick

Qaf 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. Clasts are mostly sandstone clasts. Thickness uncertain; probably as much as 50 ft locally.

Qafy 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 uncertain; probably as much as 50 ft locally.

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

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

Qal Colluvium (Quaternary)—Brown to dark-brown heterogeneous mixture of fragments of sandstone, shale, and rounded to angular igneous rocks. Forms thin veneer on steep slopes. Commonly at base of steep cliffs. Chiefly siltstone and sandstone clasts. Unconsolidated to semiconsolidated. As much as 50 ft thick

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

Qg 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

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

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

Qls 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 such as the Thistle Horn Formation. A few of the larger landslides exceed 200 ft in thickness and cover several square miles. Locally includes areas of colluvium, slump block

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

Qao 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 texture. Generally exposed 50 to 150 ft above adjacent valley floors. Ranges in thickness from about 10 to 200 ft

Qm Moraine deposits (Pleistocene)—Brown to dark-brown masses of unsorted, unstratified to semi-consolidated glacial debris. Fragments range in size from clay to boulders as much as 6 ft in diameter. Characterized by lobate shape, morainal ridges, and by knobby and kettle topography. Water-saturated silt is found downslope locally mapped as landslide deposits (Qls). Thickness as much as 200 ft

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

QTr Rubble (Pleistocene to Pliocene?)—Light-brown to gray, angular gravel, mostly medium- to coarse-grained, 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

QTsf Older coalesced alluvial-fan deposits (Quaternary to Pliocene?)—Brown to dark-brown or gray, poorly consolidated to semiconsolidated, thin- to thick-bedded, commonly crossbedded sediment of fluvial origin. Deposits consist of silt, sand, granules, pebbles, cobbles, and sparse boulders. Formed by the overlapping and interfingering of adjacent alluvial fans; form broad, low, sloping aprons at foot of adjacent highlands. Surface and near-surface deposits likely were formed during the Quaternary; at depth, these probably overlie deposits of comparable age and types formed during the Pliocene. As much as 100 ft thick locally

Tap Alluvial fan (Quaternary to Pliocene?)—Light-brown to brown silt, sand, and gravel. Deposits that underlie the Tavaputs Plateau. Mostly interbedded alluvium and colluvium along and near valley sides. As much as 100 ft thick locally

QTpm Pediment mantle (Holocene to Pliocene)—Light-brown to brown, gray, and dark-gray, thin-bedded deposits of silt, sand, granules, pebbles, cobbles, and boulders derived from adjacent uplands. Moderate to crudely bedded. Unconsolidated to well cemented by calcium carbonate. Composed of sandstone and siltstone clasts. Forms low-relief surfaces that slope gently toward valley axes. Unit includes include some alluvial-fan deposits. Ranges from about 0 ft to more than 150 ft in thickness

Deposits of the Bonneville Lake Cycle

Qbn Nearshore deposits (upper Pleistocene)—Light-gray to brownish-gray, moderately well sorted, even-bedded deposits of silt, sand, and gravel, and massive to laminated silt and clay. Chiefly of oolitic sand. In Sevier Valley, ranges from 20 to 50 ft in thickness; may be as much as 250 ft thick elsewhere

Qbo Offshore deposits (upper Pleistocene)—Light-gray to tan, thin- to medium-bedded deposits of silt and sand. Lacustrine origin. Thickness uncertain

Qbs Shoreline deposits (upper Pleistocene)—Include 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

TUJai Intrusive masses of Arapien Shale (Quaternary? to Middle Jurassic)—Generally light-colored, marked by pale-red blotches, but, in places, wholly drab gray or reddish brown. Calcareous siltstone, thin- to medium-bedded, even-bedded; locally massive. Includes intercalated, thin, lenticular beds and seams of yellowish-gray to light-brown siltstone and sandstone and a few beds of limestone. Contains thick beds of rock salt (halite), gypsum, and other evaporites. Selenite crystals are common but many outcrops. Of marine saline-basin origin. Formation is complexly deformed and shows evidence of intense compression. Weathers to badlands topography. The salt bed possibly other evaporites in the Arapien Shale has probably been mobile at least since it was deposited during the Middle Jurassic (Witkind, 1982). Some of this movement has been recent, almost imperceptible upwelling. At times, however, the salt appears to have surged upward rapidly, forcing up the overlying mudstone of the Arapien Shale, which, in turn, bowed up the country rock to form elongate, narrow diapiric folds. Subsequent erosion and removal of the salt resulted in collapse of the upwarps. Such major upwellings of the salt may have occurred during the Late Cretaceous, early Paleocene, and the latest Oligocene or Miocene. A localized upwind surge of the salt, probably during the Pleistocene, apparently deformed semiconsolidated sediment in the southern part of Sanpete Valley. Thus, the formation has several ages: the depositional age, the Middle Jurassic, but the emplacement age—the age of movement—has changed repeatedly. Symbol (TUJai) refers both the depositional age and the latest known time of mass emplacement (?. Tentative. Thickness uncertain because of intense deformation; estimates range from about 4,000 ft to as much as 13,000 ft (Spieker, 1949, p. 17; Gilliland, 1948, p. 30; Hardy, 1949, p. 16 and 17)

Tertiary detachment blocks

TUbbh Displaced block of the Crazy Hollow Formation (Tertiary)—Unbroken block of the Crazy Hollow Formation (Tcfu) carried "piggyback" to its present position, during either Oligocene(?) or Miocene time, on a block of the Green River Formation that slid valleward

TcfuGf Displaced block of Green River Formation (Tertiary)—Coherent blocks and detritus of the Green River Formation (Tgi) that have slid into their present position along a westward-sloping glide plane. The blocks have rotated somewhat in their downward movement and discordantly overlie the country rocks

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

Tsp Sevier Plateau porphyry (Tertiary to Cretaceous?)—Light-greenish-gray syenite porphyry; stock near Levan. Phenocrysts (20 percent of rock) consist of hornblende (about 15 percent) and feldspar (about 5 percent). Accessory minerals are magnetite, apatite, and sphene. Groundmass is granular and includes hornblende, orthoclase, and hornblende

Tim 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 (2 percent), and biotite (about 1 percent). Accessory minerals include apatite, magnetite, and sphene. Groundmass includes plagioclase, quartz, and potassium feldspar

Thmp Monzonite porphyry (lower Miocene to upper Oligocene)—Small stock, probably a satellite of monzonite porphyry. Phenocrysts (32 percent of rock) consist of plagioclase (andesine-labradorite) (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 sphene quartz.

Tf Hornblende monzonite porphyry flower Miocene to upper Oligocene)—Essentially similar to monzonite porphyry, described above, with the exception that this unit is very rich in hornblende. Phenocrysts are 1 inch long

Intrusive rocks from Mount Pennell (Oligocene to Miocene)—Small dikes, sills, and rounded bosses of differing composition, that are exposed near Levan and consist of intermediate-composition rocks such as diabase, monzonite, and monzonite (John, 1972). Includes lamprophyre dikes and sills in the Cedar Hills (Schultz, 1951, p. 56). Also includes, elsewhere in the area, a few dark-gray to black, thin 3-7 ft, porphyritic, hornblende dikes and sills, chiefly mineral rich in biotite (Phillips, 1962, p. 68-69; Laughlin, 1918, p. 103)

Extrusive igneous rocks and their products (Chiefly western part of the area)

Tsg Lasana Springs Volcanic Group (Oligocene)—Chiefly lithic and andesitic tuff with interbedded volcanic lava flows and volcanic mudflow breccia. Thickness uncertain; probably as much as 1,000 ft

Tmb 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. Rock is mostly andesitic, but it is mapped as a separate unit (Tfm). Thickness uncertain

Tvbc Volcanic mudflow breccia—Dark to brownish-gray, locally reddish-gray, thick-bedded to massive breccia consisting of a heterogeneous mixture of angular to subangular fragments of various kinds of rocks. Matrix is fine-grained tuff, and some blocks of sedimentary rock enclosed in a fine-grained matrix. Weathers to rounded knobs covered with boulders. Thickness unknown

Tgo Goshen Reach Formation (middle Oligocene to upper Eocene)—Volcaniclastic and pyroclastic rocks, including ash-flow and air-fall tuff, and stream-deposited conglomerate and sandstone. Dominant rock unit is a light-gray to pale-orange-brown erratic sandstone containing rounded andesite, lithic quartzite, and limestone clasts. Tuff is light gray to light brown and contains sparse andesite lapilli. Thickness ranges from about 1,000 ft to more and a few interbedded flows. Sage Valley Limestone Member is light gray, fine-grained, thin- to thick-bedded, cross-bedded limestone. Contains Reach Formation intertongues with breccia associated with Lasana Springs Volcanic Group (Thb) (Morris and Lovering, 1961, p. 126). Thickness unknown; at least 1,000 ft thick. Also correlates with the Monroe Formation (Tmf) (Witkind and Marvin, 1989, p. 544)

Tm Monroe Formation (middle Oligocene to upper Eocene)—Volcaniclastic and pyroclastic rocks, including ash-flow and welded tuff and stream-deposited conglomerate and sandstone. Dominant rock unit is a light-gray, poorly cemented, unstratified, tuffaceous sandstone containing rounded andesite, lithic quartzite, and limestone clasts. Tuff is light gray to light brown and contains sparse andesite lapilli. Thickness ranges from about 1,000 ft and a few interbedded flows. Sage Valley Limestone Member is light gray, fine-grained, thin- to thick-bedded, cross-bedded limestone. Contains Reach Formation intertongues with breccia associated with Lasana Springs Volcanic Group (Thb) (Morris and Lovering, 1961, p. 126). Thickness unknown; at least 1,000 ft thick. Also correlates with the Monrol Formation (Tmf) (Witkind and Marvin, 1989, p. 544)

Tmi Moroni Formation (middle Oligocene to upper Eocene)—Volcaniclastic and pyroclastic rocks, including ash-flow and welded tuff and stream-deposited conglomerate and sandstone. Tuff is commonly porous and friable, but locally includes lightgray, densely welded, vitric tuff. Sandstone is light gray, well sorted, and contains rounded andesite clasts. Abundant crystal fragments of quartz, sanidine, and biotite, and 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 clasts 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

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

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

Tcrg Crazy Hollow Formation (Eocene)—Red- to reddish-brown, light-yellow-brown, and locally white sandstone, shale siltstone, and some conglomerate. In a few places includes gray, thin, dense limestone beds. Shale, thin, dense limestone beds. Salt-and-pepper sandstone is light gray, fine-grained, well-sorted, detrital quartz sandstone, well-rounded chert pebbles. Fluvial and minor lacustrine deposits. Thickness ranges from 0 ft to 1,000 ft (Hunt, 1956)

Tg Green River Formation (Eocene)—Consists of a lime unit underlain by a lower unit, the tongue, of nontritic origin. Thickness of formation ranges widely, from about 500 ft to 2,000 ft

Tgi Limestone unit—Pale-yellowish-gray to yellowish-brown to light-brown, thin- to medium-bedded, even-bedded limestone and minor thin units of bedded sandstone and tuff. Limestone is dense, commonly thinly laminated, and commonly oolitic; some thin beds are coquinoid. Sandstone, light-gray, fine-grained, quartzose sandstone. Tuff is light-gray, and dark-brown to black, fine-grained, thin-bedded tuffaceous sandstone. Tuff is light gray to light brown and contains sparse andesite lapilli. Thickness ranges from about 300 ft to more than 150 ft in thickness

Tgo 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

Tgm 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

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

Jms 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

Jsr Summerville Formation (Middle Jurassic)—Reddish-brown siltstone and sandstone. Thin, even, and continuous bedding is characteristic. Many interlayered seams and thin beds of gypsum. Tidal flat deposit. 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)—Orangish-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: an upper unit of reddish-brown shaly siltstone and sandstone and a lower unit of light-gray crystalline limestone. Marine deposit. Formation ranges in thickness from 280 to 350 ft

Jcu 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

Jcl 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 descending 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 shale siltstone clasts. Fluvial deposit. Ranges in thickness from 100 to 250 ft

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

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

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

Ttc 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, light-gray and greenish-gray, thin- to medium-bedded sandstone and shaly siltstone. Lenticular. Ranges in thickness from 0 to 150 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 unit of Chinle as altered and marked by purple and white mottles. This purple-white zone, commonly at or near the base of the Chinle, Gregory and Moore (1931, p. 54-55) and Stokes (1952, p. 1-11) mapped the Temple Mountain Member as the lowermost member of the Chinle. Combined thickness of Moss Back and Temple Mountain members ranges from 70 to 175 ft

Tkm Moenkopi Formation—Consists of three parts, which together range in thickness from 0 to 1,000 ft

Upper part (Middle? and Lower Triassic)—Consists of siltstone that has altered to pseudomorphs of Thin to medium-bedded, very fine-grained sandstone and shaly siltstone. Thin, persistent, brown sandstone beds. Includes sparse discontinuous beds of silicified shale. About 1,000 ft thick

Main body—Light-bluish-gray and gray, thin- to medium-bedded shale and shaly siltstone. Sparse interlayered thin sandstone beds. Resembles upper part of Blue Gate and Tununk Members. As much as 2,000 ft thick

Emery Sandstone Member—Consists of upper and lower sandstone units, separated by a middle shale unit. Shale, siltstone, and Crypto Beds. Maximum thickness of member about 285 ft

Upper sandstone unit—Light-brown, yellowish-brown, and grayish-brown, thin- to medium-bedded, crossbedded, very fine grained to fine-grained, quartzose sandstone. Weathers to thin, regular flakes. Forms low cliffs. About 35 ft thick

Middle shale unit—Light-gray to gray, thin- and medium-bedded shale and shaly siltstone. Sandy locally. Few thin interbedded sandstone beds resemble sandstone. Ranges in thickness from about 200 to 1,000 ft

Lower sandstone unit—Light-brown, yellowish-brown, and grayish-brown, thin- to medium-bedded, very fine-grained to fine-grained, quartzose sandstone. Stands as a low cliff. About 50 ft thick

Curley Cutoff Beds—Two thin sandstone beds separated by dark-gray shale. Sandstone is light gray to light brown, locally orange brown, thin and even bedded. Locally crossbedded. Salt and pepper texture. Ranges in thickness from 0 to about 25 ft

Crypto Beds—Consists of upper and lower units, predominantly sandstone, separated by a thin shale unit. Member is about 160 ft thick

Upper unit—Buff, brown, and brownish-gray, medium- to thick-bedded, locally massive, even-textured, very fine to fine-grained sandstone. Weathers to 6,100 ft. Unit Km is not shown on the map, but it is shown on the Correlation of Map Units chart. Unit is a widespread stratigraphic information

Buck Tongue of Mancos Shale (Upper Cretaceous)—Gray to dark-gray shale interbedded with lenses of brown to grayish-brown quartzose sandstone. Marine deposit. About 500 ft thick

Blue Gate Member—Locally appears as an unbroken sequence of shale beds. In some places, Emery Sandstone Member separates the Blue Gate into an upper member (Kmbu) and the main body of the member (Kmbg), which underlies the Emery

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

Tunuk 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 50 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 bluish-gray and gray with bands of yellow, green, and purple. Mostly bentonitic mudstone and claystone. 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. Tidal flat deposit. 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)—Orangish-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: an upper unit of reddish-brown shaly siltstone and sandstone and a lower unit of light-gray 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 descending 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 shale siltstone clasts. Fluvial deposit. Ranges in thickness from 100 to 250 ft

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

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, light-gray and greenish-gray, thin- to medium-bedded sandstone and shaly siltstone. Lenticular. Ranges in thickness from 0 to 150 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 unit of Chinle as altered and marked by purple and white mottles. This purple-white zone, commonly at or near the base of the Chinle, Gregory and Moore (1931, p. 54-55) and Stokes (1952, p. 1-11) mapped the Temple Mountain Member as the lowermost member of the Chinle. Combined thickness of Moss Back and Temple Mountain members ranges from 70 to 175 ft

Moenkopi Formation—Consists of three parts, which together range in thickness from 0 to 1,000 ft

Upper part (Middle? and Lower Triassic)—Consists of siltstone that has altered to pseudomorphs of Thin to medium-bedded, very fine-grained sandstone and shaly siltstone. Thin, persistent, brown sandstone beds. Includes sparse discontinuous beds of silicified shale. About 1,000 ft thick

Main body—Light-bluish-gray and gray, thin- to medium-bedded shale and shaly siltstone. Sparse interlayered thin sandstone beds. Resembles upper part of Blue Gate and Tununk Members. As much as 2,000 ft thick

Emery Sandstone Member—Consists of upper and lower sandstone units, separated by a middle shale unit. Shale, siltstone, and Crypto Beds. Maximum thickness of member about 285 ft

Upper sandstone unit—Light-brown, yellowish-brown, and grayish-brown, thin- to medium-bedded, locally crossbedded, very fine grained to fine-grained, quartzose sandstone. Weathers to thin, regular flakes. Forms low cliffs. About 35 ft thick

Middle shale unit—Light-gray to gray, thin- and medium-bedded shale and shaly siltstone. Sandy locally. Few thin interbedded sandstone beds resemble sandstone. Ranges in thickness from about 200 to 1,000 ft

Lower sandstone unit—Light-brown, yellowish-brown, and grayish-brown, thin- to medium-bedded, very fine-grained to fine-grained, quartzose sandstone. Stands as a low cliff. About 50 ft thick

Curley Cutoff Beds—Two thin sandstone beds separated by dark-gray shale. Sandstone is light gray to light brown, locally orange brown, thin and even bedded. Locally crossbedded. Salt and pepper texture. Ranges in thickness from 0 to about 25 ft

Crypto Beds—Consists of upper and lower units, predominantly sandstone, separated by a thin shale unit. Member is about 160 ft thick

Upper unit—Buff, brown, and brownish-gray, medium- to thick-bedded, locally massive, even-textured, very fine to fine-grained sandstone. Weathers to 6,100 ft. Unit Km is not shown on the map, but it is shown on the Correlation of Map Units chart. Unit is a widespread stratigraphic information

Buck Tongue of Mancos Shale (Upper Cretaceous)—Gray to dark-gray shale interbedded with lenses of brown to grayish-brown quartzose sandstone. Marine deposit. About 500 ft thick

Blue Gate Member—Locally appears as an unbroken sequence of shale beds. In some places, Emery Sandstone Member separates the Blue Gate into an upper member (Kmbu) and the main body of the member (Kmbg), which underlies the Emery

Paleozoic strata

Kaibab Limestone (Lower Permian)—Light-brown to brown, thin- to medium-bedded, even-bedded limestone. Lenticular. Locally contains a few thin, dense sandstone at base that reflects reworking of underlying Coconino Sandstone of Cutler Formation. Contains chert geodes. Fossiliferous. Marine 30' x 60' quadrangles, Carbon, Emery, Sanpete, Utah, and Wasatch Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1937, scale 1:100,000.

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Paleozoic rocks

Kaibab Limestone (Lower Permian)—Light-brown to brown, thin- to medium-bedded, even-bedded limestone. Lenticular. Locally contains a few thin, dense sandstone at base that reflects reworking of underlying Coconino Sandstone of Cutler Formation. Contains chert geodes. Fossiliferous. Marine 30' x 60' quadrangles, Carbon, Emery, Sanpete, Utah, and Wasatch Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1937, scale 1:100,000.

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