UTAH GEOLOGICAL SURVEY
a divison of
Utah Department of Natural Resources
in cooperation with the
National Park Service
and **Brigham Young University Department of Geological Sciences**

Plate 1
Utah Geological Survey Miscellaneous Publication 07-1
Geologic Map of the Golden Throne Quadrangle

Base from U.S. Geological Survey, Golden Throne 7.5' quadrangle, 2002
Geologic data and base map in NAD 1927
Shaded topography generated from digital elevation data

SCALE 1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
STRUCTURAL CONTOUR INTERVAL 500 FEET

Field mapping by authors in 2005
Geologic structural contours, J. Buck Ehler
GIS assistance, Darryl Greer and J. Buck Ehler
Cartography, J. Buck Ehler and James Parker
Project Manager, Grant C. Willis
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Utah Geological Survey, 1594 W. North Temple,
P.O. Box 146100, Salt Lake City, Utah 84114-6100.
Phone: 801-537-3300; fax 801-537-3400
geology.utah.gov

11°56'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2007

GEOLOGIC MAP OF THE GOLDEN THRONE QUADRANGLE, WAYNE AND GARFIELD COUNTIES, UTAH

by
Daniel H. Martin[1], Thomas H. Morris[2], Samuel C. Sorber[3], and James L. Eddleman[4]
2007

[1]Fronterra Geosciences, 5100 North Brookline Ave., Oklahoma City, Oklahoma
[2]Brigham Young University, Department of Geological Sciences, Provo, Utah
[3]ExxonMobil Exploration Company, Houston, Texas
[4]Comanche Exploration Company, LLC, 6520 North Western Avenue, Suite 300, Oklahoma City, Oklahoma

Key access roads, selected trails, and prominent features in and near Capitol Reef National Park shown in brown. Condition and status of roads and trails may change over time. Some not shown. From data provided by National Park Service. See plate 2 for explanation.

UTAH
QUADRANGLE LOCATION

1	2	3	1.Twin Rocks 2. Fruita 3. Cainville 4. Grover 5. Notom 6. Lower Bowns Reservoir 7. Bear Canyon 8. Sandy Creek Benches
4		5	
6	7	8	

ADJOINING 7.5' QUADRANGLE NAMES

DESCRIPTION OF MAP UNITS

QUATERNARY DEPOSITS

Qal — **Alluvial and floodplain deposits (Quaternary)** – Poorly sorted material found in modern streams and rivers. Includes clay- to boulder-size sediments composed of mudstone, siltstone, sandstone, limestone, and volcanic particles. Particles of volcanic origin are found only in the Pleasant Creek drainage. 0 to 10 feet (0-3 m) thick.

Qal$_2$ — **Alluvial and floodplain deposits of a former river level (Quaternary)** – Located 10 to 20 feet (3-6 m) above current floodplain. Clay- to boulder-size sediments composed of mudstone, siltstone, sandstone, limestone, and volcanic particles. Particles of volcanic origin are found only in the Pleasant Creek drainage. 0 to 20 feet (0-6 m) thick.

Qmt — **Talus deposits (Quaternary)** – Talus deposits from mass movement of sediment by rock falls, rock slides, and slumps. Sediment is composed of clay- to boulder-size particles. Commonly found where an easily erodible rock layer is located directly under a more resistant rock layer. For example, talus deposits composed of the Sinbad Member of the Moenkopi Formation overlie the Black Dragon Member in many areas and talus deposits composed of the Wingate and Kayenta Formations overlie the Owl Creek Member of the Chinle Formation. Locally applies to deposits over pediment-like surfaces. 0 to 30 feet (0-9 m) thick.

Qatv$_1$, Qatv$_2$, Qatpu — **Volcanic boulder terrace deposits (Quaternary)** – Sediments overlying river-cut strath terraces sourced from volcanic-covered highlands to the west. Composed of pebble- to boulder-size extrusive (basaltic, andesitic, and tuffaceous) igneous rocks as well as clay- to boulder-size locally-derived material consisting of mudstone, siltstone, sandstone, and limestone. Terraces in the Glen Canyon Group section of Pleasant Creek are divided into two groupings based on work by Eddleman (2005) (Qatv$_1$, Qatv$_2$). All other terraces with these characteristics are labeled Qatpu (undivided). Terraces have an easily recognized dark coloration due to the presence of the black volcanic boulders. 0 to 20 feet (0-6 m) thick.

Qmtv — **Volcanic boulder colluvial deposits (Quaternary)** – Predominantly composed of talus and colluvial material weathering from volcanic boulder terraces. Commonly includes large extrusive (basaltic, andesitic, and tuffaceous) igneous boulders as well as other locally derived material. 0 to 5 feet (0-1.5 m) thick.

Qatlo — **Locally derived old terrace deposits (Quaternary)** – Terrace deposits derived from local sources, composed of clay- to boulder-size particles of mudstone, siltstone, sandstone, and limestone. Typically very well cemented. Commonly located at the mouths of canyons that cut into Miners Mountain. 5 to 60 feet (1.5-18 m) thick.

Qe — **Eolian deposits (Quaternary)** – Deposits composed of very well sorted, well rounded, wind-blown sand. Commonly occurs between domes of the Navajo Sandstone and in point-bar areas of stream channels. 0 to 10 feet (0-3 m) thick.

Qms — **Landslide deposits (Quaternary)** – A slump block composed of the Moenkopi Formation that has slid over the Chinle Formation in an area of steeply dipping beds. Source location and slump scarp are not mappable due to subsequent erosion. Moenkopi block has retained some bedding and cohesion. 50 to 80 feet (15-25 m) thick.

JURASSIC ROCKS

Je — **Entrada Sandstone (Middle Jurassic)** – Grayish-red to moderate-red mudstone interbedded with moderate-reddish-orange, fine-grained sandstone. Grayish-orange, cross-bedded, eolian sandstone also found at horizons within the quadrangle. The majority of the Entrada Sandstone in this quadrangle is referred to as the "earthy" (tidal flat) facies as opposed to the "slick rock" (eolian) facies famous in Arches National Park (Peterson, 1988). Forms slopes. 450 to 480 feet (135-145 m) thick.

Jcwb — **Upper Winsor (Banded) Member of the Carmel Formation (Middle Jurassic)** – Pale-reddish-brown siltstone and mudstone with gypsum stringers interbedded with pale-olive mudstone. Forms slopes. Beds are commonly deformed due to the movement of gypsum that was originally deposited in underlying members. 180 to 200 feet (55-60 m) thick.

Jcwg — **Lower Winsor (Gypsum) Member of the Carmel Formation (Middle Jurassic)** – Light-gray to white gypsum, pale-reddish-brown siltstone and mudstone beds with gypsum stringers and light-gray to greenish-gray mudstone. Forms slopes and ledges. Ledges are composed of 20 feet (7 m) thick layers of gypsum. The beds are commonly deformed due to movement of gypsum layers. 180 to 200 feet (55-60 m) thick.

Jcpr — **Paria River Member of the Carmel Formation (Middle Jurassic)** – Moderate-reddish-brown mudstone and siltstone, yellowish-gray siltstone, and light-gray to white gypsum. Forms ledges. The gypsum bed is locally discontinuous due to gypsum flow and dissolution. 150 to 200 feet (45-60 m) thick.

Jpc — **Page Sandstone (Middle Jurassic)** – The Page Sandstone in this quadrangle is composed of two members: the Harris Wash Member (lower) and the Thousand Pockets Member (upper), that are divided by the Judd Hollow Tongue, a member of the overlying Carmel Formation. The Judd Hollow Tongue is included in the Page Sandstone map unit. The Harris Wash Member is 92 to 113 feet (28-35 m) thick. It is composed of very-pale-orange to pale-yellowish-orange, fine- to medium-grained, trough cross- stratified sandstone. Based on pollen assemblages and age, the upper part of the Judd Hollow Tongue correlates with the Crystal Creek Member of the Carmel Formation as mapped in southwestern Utah, and the Judd Hollow Tongue as mapped in south-central Utah (Douglas A. Sprinkel and Hellmut H. Doelling, personal communication, 2005). It is composed of ripple-laminated, moderate-reddish-brown to dark-reddish-brown mudstone and sandstone with local interbeds of limestone. The Judd Hollow Tongue forms slopes and ranges from 10 to 17 feet (3-5 m) thick. The Thousand Pockets Member is composed of very-pale-orange to pale-yellowish-orange, fine- to medium-grained, cross-stratified sandstone with planar-laminated and contorted beds. It is 17 to 32 feet (5-9 m) thick. The Page Sandstone forms ledges, cliffs, and the caprock of many of the prominent geographical features within the quadrangle, including the Golden Throne monolith. The Page Sandstone can be distinguished from the underlying Navajo Sandstone by the abrupt change in weathering style. The lower portion of the Page Sandstone forms sheer cliffs above the rounded expression of the Navajo Sandstone. Total map unit thickness ranges from 135 to 155 feet (40-50 m). It thins slightly to the south.

Unconformity

Jn — **Navajo Sandstone (Lower Jurassic)** – Very-pale-orange to pale-gray, large-scale trough cross-stratified, very fine to fine-grained sandstone. Localized soft-sediment deformation is observable in the top 200 feet (60 m) and may be associated with cataclysmic failure of interdune lakes within the Navajo erg (Eisenberg, 2003). Forms cliffs and rounded domes. The map contact in the transitional facies zone between the Navajo and Kayenta Formations is placed at the top of the last prominent red shale bed below uniform sandstone. Sandstones beneath this red shale are both eolian and fluvial in nature and have been placed within the Kayenta Formation. 1000 to 1300 feet (300-400 m) thick.

Jk — **Kayenta Formation (Lower Jurassic)** – Moderate-reddish-brown to moderate-reddish-orange, cross-bedded to irregularly-bedded, siltstone and very fine to coarse-grained sandstone. Forms stepped topography composed of ledges (locally cliffs) and slopes. The upper approximately 100 feet (30 m) was mapped by Sorber and others (2007) and Doelling and Kuehne (2007) as the basal member of the Navajo Sandstone within the adjacent Twin Rocks quadrangle, where the eolian nature is more prominent. 300 to 400 feet (90-120 m) thick.

JURASSIC - TRIASSIC ROCKS

JꞦw — **Wingate Sandstone (Lower Jurassic to Triassic[?])** – Light-brown to moderate-reddish-brown, trough cross-stratified to massive, very fine to fine-grained sandstone. Forms the sheer cliffs of the western escarpment of the Waterpocket Fold. Walls highly fractured and commonly covered with black to dark-brown desert varnish. 350 to 400 feet (110-120 m) thick.

Unconformity

TRIASSIC ROCKS

Ꞧco — **Owl Rock Member of the Chinle Formation (Upper Triassic)** – Orange and purple mudstone, siltstone, and fine-grained sandstone with 1- to 3- foot- (0.3-1 m) thick interbeds of mottled dusky-red to pale-yellowish-green limestone, interpreted as paleosols with abundant rhizoliths and bioturbated horizons. Forms slopes. Member commonly covered by talus deposits of the overlying Wingate and Kayenta Sandstones. 180 to 220 feet (55-70 m).

Ꞧcp — **Petrified Forest Member of the Chinle Formation (Upper Triassic)** – Moderate-reddish-brown mudstone and siltstone interbedded with carbonate nodule horizons 2 feet (0.6 m) thick interpreted as paleosols. Contains petrified wood. The upper bed of the member consists of a locally extensive dark-reddish-brown, ledge-forming, medium- to coarse-grained, cross-bedded sandstone informally called the "Capitol Reef Bed." Most of the member forms slopes. 180 to 200 feet (55-60 m) thick.

Ꞧcm — **Monitor Butte Member of the Chinle Formation (Upper Triassic)** – Light-olive-gray to greenish-gray bentonitic claystone with thin, dusky-brown to dark-yellowish-orange, medium- to coarse-grained, cross-bedded, channelized sandstone beds. Forms slopes. 150 to 200 feet (45-60 m) thick.

Ꞧcu — **Chinle Formation undifferentiated upper part (Upper Triassic)** – Includes the Owl Rock, Petrified Forest, and Monitor Butte Members. Undivided due to difficulty in identifying members because of Quaternary cover and high dip of beds on the west flank of the Miners Mountain uplift. 510 to 600 feet (155-190 m) thick.

Ꞧcs — **Shinarump Member of the Chinle Formation (Upper Triassic)** – Grayish-orange to very-pale-orange, medium- to very coarse grained, cross-bedded conglomeratic sandstone. Contains petrified wood. Shinarump beds are discontinuous due to its braided fluvial depositional history. The member contains uranium that has been historically mined within the quadrangle. Forms ledges and cliffs. 0 to 30 feet (0-9 m) thick.

Unconformity

Ꞧmm — **Moody Canyon Member of the Moenkopi Formation (Lower Triassic)** – Moderate-reddish-brown to moderate-reddish-orange laminated mudstone and siltstone with sparse ripple-laminated, fine-grained sandstone with gypsum-filled fractures and bedding-parallel stringers. Typically forms slopes but can be cliff-forming if overlain by the Shinarump Member. 250 to 300 feet (75-90 m) thick.

Ꞧmt — **Torrey Member of the Moenkopi Formation (Lower Triassic)** – Moderate-reddish-brown to moderate-reddish-orange mudstone, siltstone and fine- to medium-grained sandstone. Contains "ripple rock" and reptilian trackways. Forms ledges and slopes. 200 to 220 feet (60-70 m) thick.

Ꞧms — **Sinbad Limestone Member of the Moenkopi Formation (Lower Triassic)** – Very-pale-orange to grayish-orange limestone and dolostone with interbeds of calcareous siltstone, sandstone, and algal boundstone. Upper bed commonly contains oolitic grains. Forms cliffs above Black Dragon Member. 40 to 70 feet (10-20 m) thick.

Ꞧmb — **Black Dragon Member of the Moenkopi Formation (Lower Triassic)** – Moderate-reddish-brown to moderate-reddish-orange, interbedded mudstone, siltstone, and sandstone with gypsum stringers. Forms slopes. In many areas undercuts the overlying Sinbad Limestone Member and is commonly covered by Sinbad talus. 50 to 70 feet (15-20 m) thick.

Unconformity

PERMIAN ROCKS

Pk — **Kaibab Limestone (Lower Permian)** – Upper 100 feet (30 m) is composed of very-light-gray to yellowish-gray shale and carbonate beds with calcrete and silcrete nodules. Lower portion is composed of pale-gray interbedded carbonate and light-gray, fine-grained, calcareous sandstone beds. Locally contains abundant glauconite grains. Forms slopes and ledges. 500 to 550 feet (150-170 m) thick.

Pc — **Cutler Group undivided (Lower Permian)** – Consists of light-gray to yellowish-gray, fine- to medium- grained, trough crossed-stratified sandstones. Distinguished from the overlying Kaibab Limestone by the absence of any carbonate beds. Undivided in this locality due to the absence of the Organ Rock Shale between White Rim Sandstone and Cedar Mesa Sandstone. Base not exposed within the quadrangle. Forms sheer cliffs. Thickness is at least 1,500 feet (500 m).

PALEOZOIC ROCKS

Pu — **Paleozoic undivided** – Subsurface rocks.

PRECAMBRIAN ROCKS

pC — **Precambrian undivided** – Subsurface rocks.

GEOLOGIC SYMBOLS

Contact

High-angle normal or reverse fault – Bar and ball on downthrown side; dashed where approximately located; dotted where concealed; arrows show component of strike-slip movement; tick mark shows approximately where sense of offset changes on scissor fault

Joints – Showing areas with prominent joint sets (only most prominent shown)

Anticline – Showing trace of the axial plane of the Miners Mountain anticline

Syncline – Showing trace of the axial plane

Monocline – Showing trace of the Teasdale monocline

—1500– – – – – –
Structural contours – Drawn on top of the Black Dragon Member of the Moenkopi Formation; dashed where projected; units are in feet above sea level. Contour interval 500 feet.

10
Strike and dip of bedding

Near vertical joints within the Navajo Sandstone

A——A'
Line of cross section

ROADS AND TRAILS

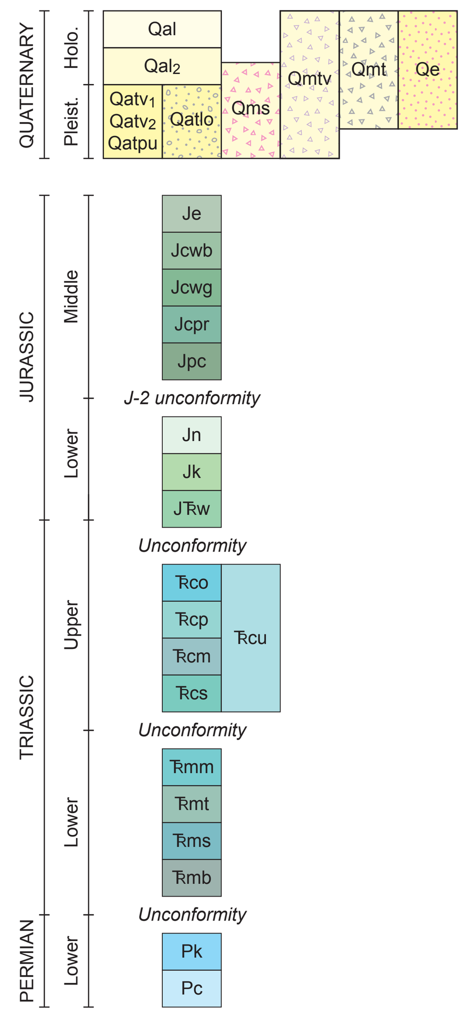
Paved road

Gravel and dirt road; 4WD = four-wheel drive

Trail

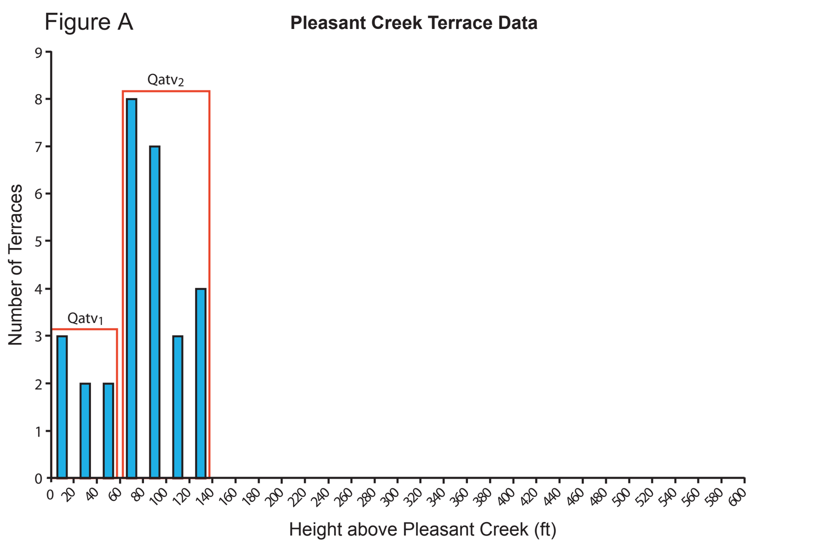
Key access roads, selected trails, and prominent features in and near Capitol Reef National Park shown in brown. Condition and status of roads and trails may change over time. Some not shown. From data provided by National Park Service.

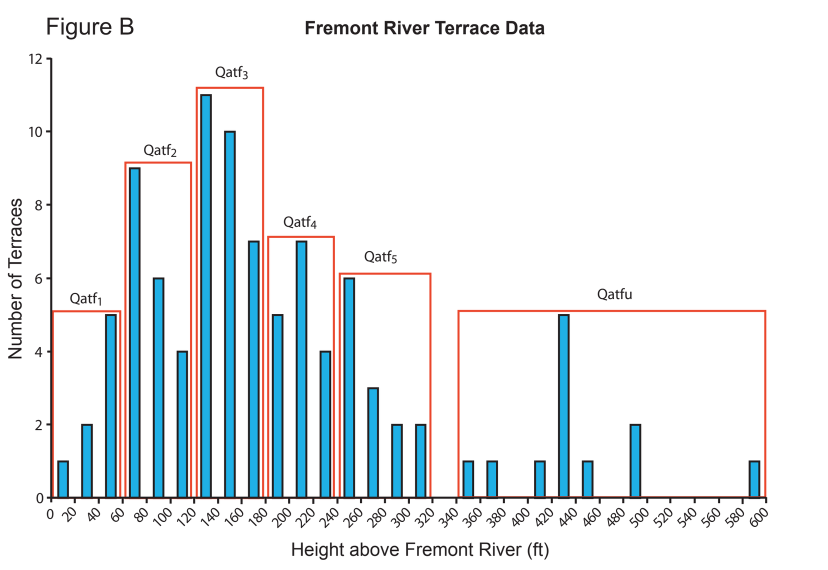
CORRELATION OF GEOLOGIC UNITS



LITHOLOGIC COLUMN

SYSTEM	MAP SYMBOL	FORMATION - MEMBER			THICKNESS Feet (Meters)	LITHOLOGY - ENVIRONMENT
JURASSIC	Je	San Rafael Group	Entrada Sandstone		450-480 (135-145)	tidal flat / erg margin
	Jcwb		Carmel Formation	Upper Winsor (banded)	180-200 (55-60)	marine
	Jcwg			Lower Winsor (gypsum)	180-200 (55-60)	
	Jcpr			Paria River Member	150-200 (45-60)	
	Jpc		Page Sandstone / Judd Hollow Member Carmel Formation		135-155 (40-50)	eolian
	Jn	Glen Canyon Group	Navajo Sandstone		1000-1300 (300-400)	eolian
	Jk		Kayenta Formation		300-400 (90-120)	fluvial
	JꞦw		Wingate Sandstone		350-400 (110-120)	eolian
TRIASSIC	Ꞧco	Chinle Formation		Owl Rock Member	180-220 (55-70)	lacustrine / fluvial
	Ꞧcp			Petrified Forest Member	180-200 (55-60)	
	Ꞧcm			Monitor Butte Member	150-200 (45-60)	
	Ꞧcs			Shinarump Member	0-30 (0-9)	
	Ꞧmm	Moenkopi Formation		Moody Canyon Member	250-300 (75-90)	coastal plain and tidal flat
	Ꞧmt			Torrey Member	200-220 (60-70)	
	Ꞧms			Sinbad Limestone Mbr.	40-70 (10-20)	marine
	Ꞧmb			Black Dragon Member	50-70 (15-20)	
PERMIAN	Pk	Kaibab Limestone			500-550 (150-170)	marine
	Pc	Cutler Group undivided			1500 (500)	eolian





Volcanic Boulder-covered Strath Terraces and Landscape Evolution

Volcanic Boulder-covered Strath Terraces within the Glen Canyon Group Section of Pleasant Creek Canyon – from Eddleman (2005)

Boulder-covered strath terraces are landforms carved into the relatively resistant bedrock of the Pleasant Creek drainage. These fluvial terraces and their associated boulder deposits at one time represented the active river floor, but have since been abandoned. These terraces help to preserve stream bed histories and create an ideal surface with which to characterize overall drainage development.

The influence of nearby glaciated highlands on the landscape and drainage morphology has been significant within Pleasant Creek and surrounding drainages. Research suggests that strath terrace development (widening of the floodplain) and deposition occurred as Pleasant Creek responded to dramatic increases in discharge and sediment flux during glacial maxima/deglacial climate phases. Incision and subsequent abandonment of strath terraces began as drainages responded to continued elevated discharge (due to glacial retreat) and an overall decrease in sediment during deglacial/interglacial climate phases.

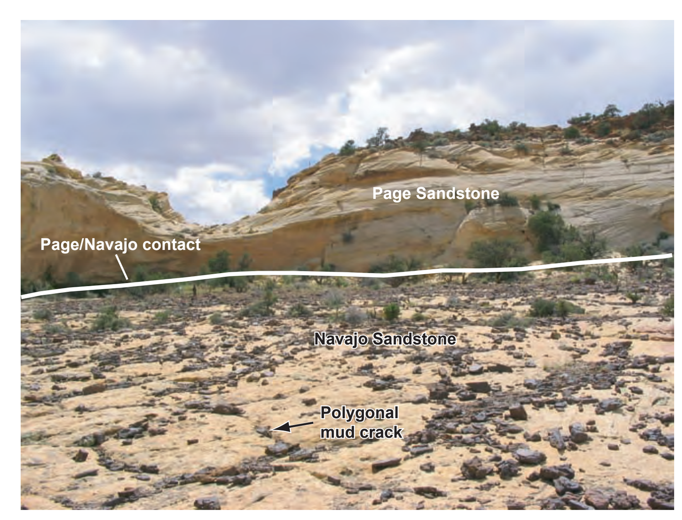
Strath terrace populations were analyzed in an attempt to understand landscape evolution. Terraces were placed into 20-foot (6 m) bins and then grouped into larger terrace levels based on natural breaks in population data (occurring in intervals of approximately 60-80 feet (20-25 m)) that display multiple modes. Results for Pleasant Creek were plotted (figure A) and two terrace levels, labeled Qatv$_2$ and Qatv$_1$ respectively, were interpreted. An identical analysis for the Fremont River drainage (approximately 10 miles [16 km] to the north in the Fruita 7.5' quadrangle; McLelland and others, 2007) yields similar results and was used in a comparative analysis between drainages (figure B).

A Schmidt Hammer is a piston impact device designed to measure the hardness of a surface. Surface hardness can provide a valuable measure of rock surface weathering and therefore relative terrain age. A Schmidt Hammer was used to obtain quantitative data (Schmidt Hammer rebound or R-values) on the hardness of volcanic boulder deposits on strath terraces. Schmidt Hammer results indicate that elevation change between strath terraces is accompanied by a coincident change in mean R-values wherein the higher the elevation of the terrace above the present stream bed, the lower the mean R-values become. Mean Schmidt Hammer data (table 1) confirms terrace level designations (figures A and B) for both the Pleasant Creek and Fremont River drainages. Schmidt Hammer data also highlight very similar mean R-values for the most recent terrace levels of both the Pleasant Creek and Fremont River drainages (table 1).

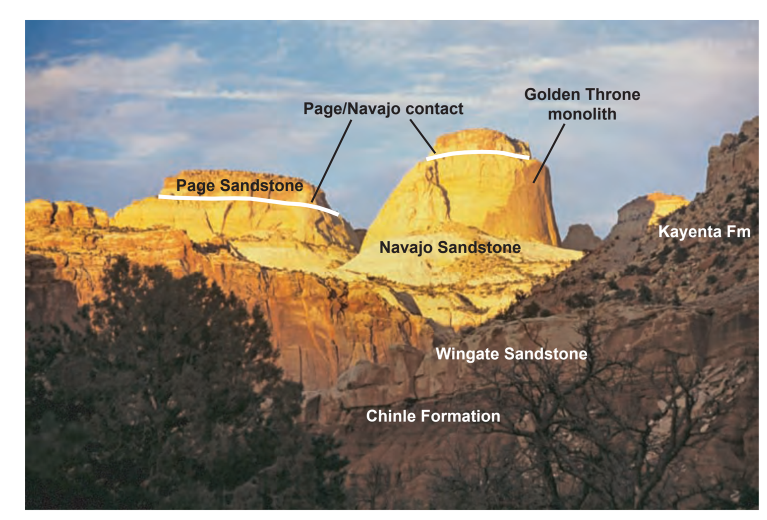
Results, based on terrace populations and Schmidt Hammer analysis, indicate that the Pleasant Creek drainage is likely much younger than the larger Fremont River drainage. Data also supports the conclusion that correlation exists between the Pleasant Creek terrace levels (Qatv$_1$ and Qatv$_2$) and the two lowest (most recent) terrace levels within the Fremont River (Qatf$_1$ and Qatf$_2$). This correlation is significant and illustrates that the root cause of drainage development and incision may be a forcing mechanism that is extrabasinal in nature. We suggest that the most probable forcing mechanism was regional Pleistocene glacial-interglacial climate cycles.

Table 1. *Summary of strath terrace elevation and Schmidt hammer data for both the Pleasant Creek and Fremont River drainages.*

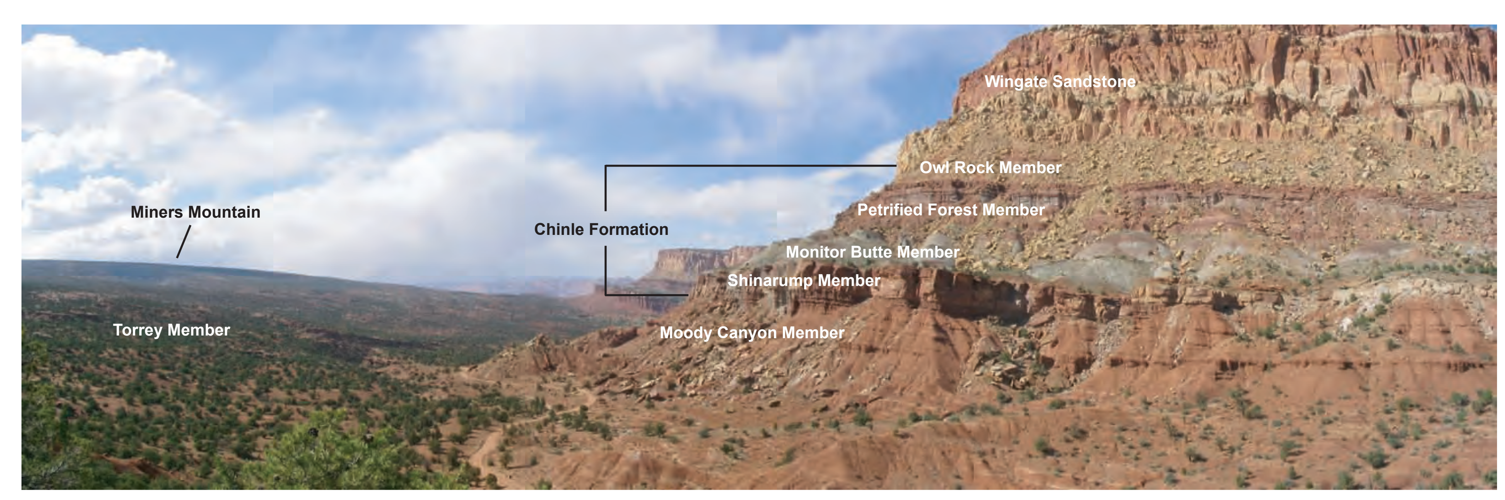
Fremont Terrace Profiles	Elevation Above Current Stream Bed	Mean Schmidt Hammer R-Values	**Pleasant Creek Profiles**	Elevation Above Current Stream Bed	Mean Schmidt Hammer R-Values
Qatfu	> 381 ft.	33.59			
Qatfu	340 - 380 ft.	37.66			
Qatf$_5$	241 - 320 ft.	39.22			
Qatf$_4$	181 - 240 ft.	39.30			
Qatf$_3$	121 - 180 ft.	44.87			
Qatf$_2$	61 - 120 ft.	46.55	Qatv$_2$	61 - 140 ft.	45.01
Qatf$_1$	< 60 ft.	52.46	Qatv$_1$	< 60 ft.	50.02
Present			Present		



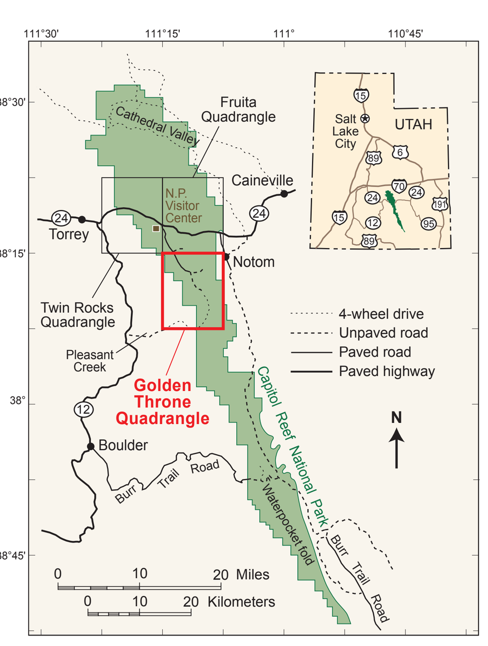
Polygonal mud cracks formed at the J2 unconformity between the Navajo Sandstone and Page Sandstone. Black rocks are mineralized sandstone blocks eroding out of fractures in the Page and Navajo Sandstones.



View looking east towards the Golden Throne monolith. The Golden Throne is composed primarily of the Lower Jurassic Navajo Sandstone. It is capped by the Middle Jurassic Page Sandstone.



View looking north up the western escarpment on the Waterpocket fold (Miners Mountain segment).



Location of Golden Throne quadrangle in Capitol Reef National Park.

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DISCLAIMER

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