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## **GEOLOGIC ROAD GUIDES TO GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, KANE AND GARFIELD COUNTIES, UTAH**



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### **GENERAL DESCRIPTION**

**Please check with Grand Staircase-Escalante National Monument officials for road closures and other travel restrictions in the monument. Please remember collecting rocks, fossils, and other artifacts is forbidden in the monument.**

Hole-in-the-Rock road (53.3 miles) .....	p. 13
Circle Cliffs (Burr Trail-Wolverine Loop) (54.0 miles) .....	p. 20
Kanab to Big Water Along U.S. Highway 89 (70.1 miles).....	p. 23
Johnson Canyon-Cannonville (50.8 miles).....	p. 30
Cottonwood Wash (48.3 miles).....	p. 37
Cannonville to Boulder Along Utah State Highway 12 (74.1 miles).....	p. 44
Collet Canyon-Croton Road (72.8 miles) .....	p. 51
Alvey Wash - Smoky Mountain Road (64.2 miles).....	p. 58
Kitchen Corral Wash (18.8 miles).....	p. 65
Total logged.....	506.4 miles

Grand Staircase-Escalante National Monument, administered by the Bureau of Land Management (BLM), was established by presidential proclamation on September 18, 1996, to protect an array of geological, paleontological, historical, archaeological, and biological resources. The monument covers about 1.9 million acres of land in south-central Utah (figure 1). About 68 percent of the monument is in Kane County, while the remaining 32 percent is in Garfield County. The monument is surrounded on three sides primarily by national forest and national park lands, and by other BLM administered lands to the south and west. Kodachrome State Park also adjoins the monument near Cannonville.

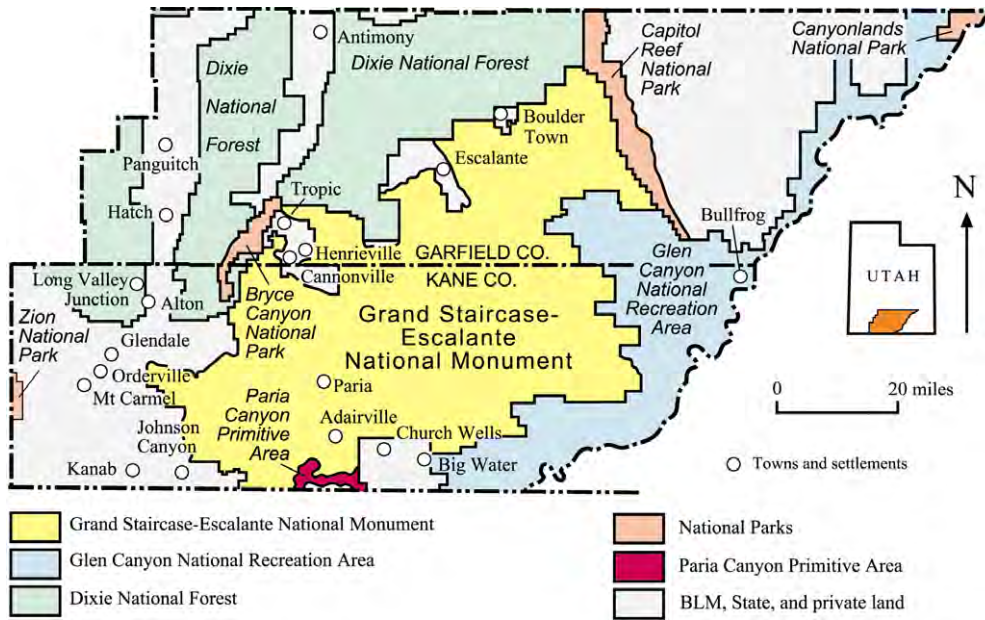


Figure 1. Index map for Grand Staircase-Escalante National Monument in Garfield and Kane Counties, Utah. The 1.9-million-acre monument is encircled by national parks, a national recreation area, a primitive area, and a national forest.

The monument is located within the Colorado Plateau physiographic province, near its western margin. It is bordered by the gateway communities of Boulder, Escalante, Henrieville, Cannonville, Tropic, Glendale, Kanab, and Big Water (figures 1 and 2). Annual precipitation in the region varies from

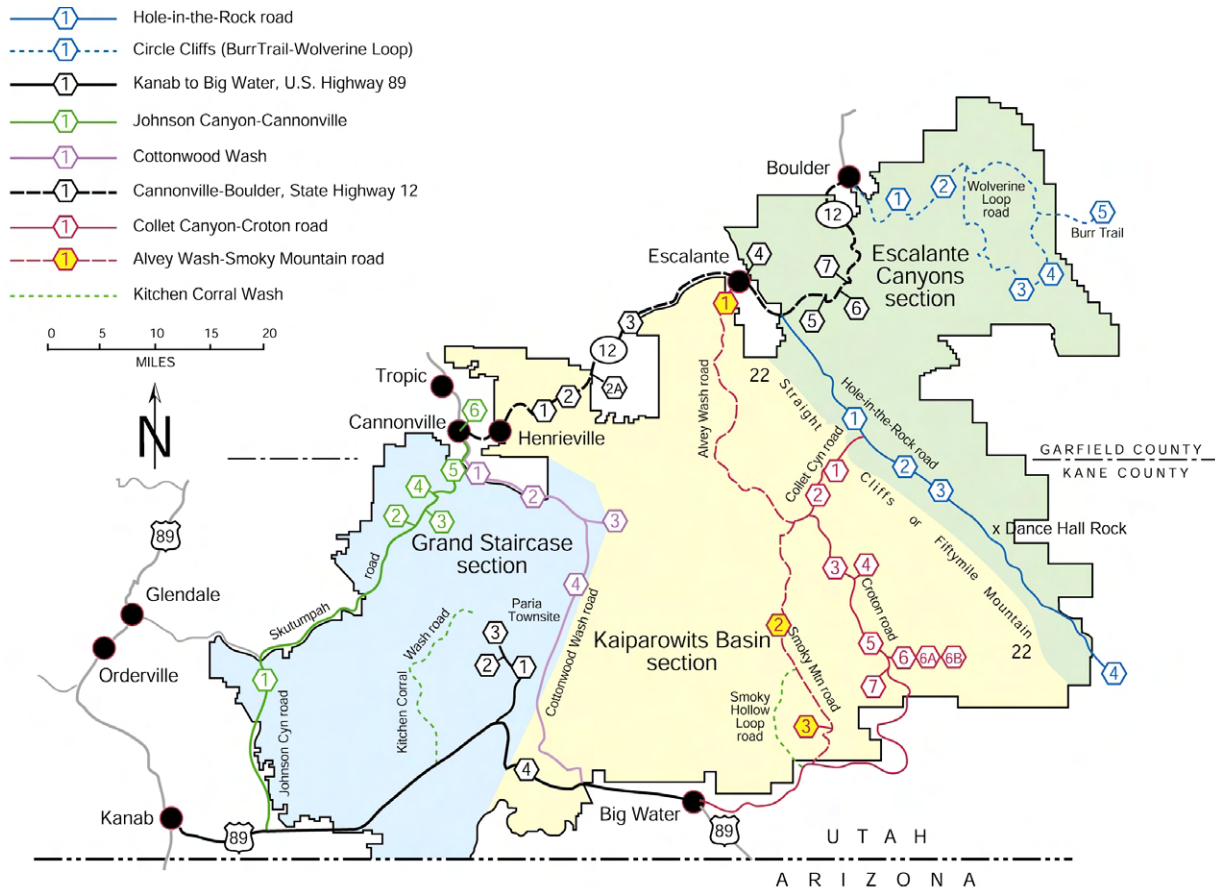


Figure 2. Map showing the geologic road guide routes, stops, and major geographic features within Grand Staircase-Escalante National Monument in southern Utah. The Grand Staircase section is shown in blue, the Kaiparowits Basin section in yellow, and the Escalante Canyons section in green.

about six inches at the lowest altitudes near Lake Powell (4,000 ft), to about 25 inches at the highest altitudes near Canaan Peak (9,280 ft). The variations in altitude and precipitation produce three climatic zones: upland, semi-desert, and desert. At the highest altitudes, precipitation falls primarily during the winter. The majority of precipitation in the semi-desert and desert areas occurs during the summer months.

## **GEOLOGIC HISTORY**

Nearly 275 million years of geologic history is revealed in the exposed rocks of the monument (Baars, 1972; Hintze, 1988) (figure 3). The oldest rocks (Permian) record a time when the North American plate was situated such that the equator angled northeasterly from southern California and across the southeast corner of Utah. The area was a marginal-marine lowland of streams, flood plains, and tidal flats, with deposition of red sandstone and mudstone beds. The sea lay to the west, but it occasionally spread eastward into the area, depositing limestone beds that are now interbedded with the sandstone and mudstone. The Hermit Shale, Toroweap Formation, Kaibab Limestone, and Moenkopi Formation (Blakey and others, 1993; Blakey, 1996), which crop out in the Circle Cliffs and at Buckskin Mountain, record the events of the first 35 million years of exposed geologic history in the monument. A missing record of less than 10 million years separates the last rocks of the Permian Period from overlying rocks of the Triassic Period (figure 3).

Evidence for climatic regimes, environments of deposition, and other paleohistoric events is available only from the rocks that we currently see in the monument, or only 43 percent of the 275-million-year interval.

One might ask what happened during the remaining 57 percent of time. Strata may have been deposited, only to be eroded before the next sequence was laid down, possible in environments that differ from those recorded in the rocks that are present. Unfortunately, the missing intervals are generally not recorded in neighboring localities; the events that affected the monument affected the region similarly. Nevertheless, there is a wealth of information found in the 43 percent of the rocks that are present, and much information remains to be gleaned from them.

The Upper Triassic rocks of the Chinle Formation in the Circle Cliffs section preserve examples of flood-plain deposits that were choked with volcanic ash (Dubiel, 1994).

Following the Late Triassic, and a period of 5 to 10 million years of non-deposition and erosion, sand was deposited during Early Jurassic time (210 to 185 million years ago). In the eastern part of the monument (Escalante Canyons section as described below), this sand was initially deposited in a sand-dune desert (Wingate Sandstone). The desert environment changed for a time and streams deposited sand in channels and overbank deposits on flood plains (Kayenta Formation). The desert climate returned and sand was again deposited in a huge area of sand dunes (Navajo Sandstone). In the western part of the monument (the Grand Staircase section as described below), Lower Jurassic tidal flats (lower Moenave Formation) gradually changed to flood plains (upper Moenave and Kayenta Formations), and finally ended in a wind-blown sand environment (Navajo Sandstone). These Lower Jurassic rocks form the Vermilion and White Cliffs in the Grand Staircase section, and make up the walls of the canyon and tributary canyons of the Escalante River. Many people consider these Lower Jurassic rocks to be the most interesting and scenic of the monument.

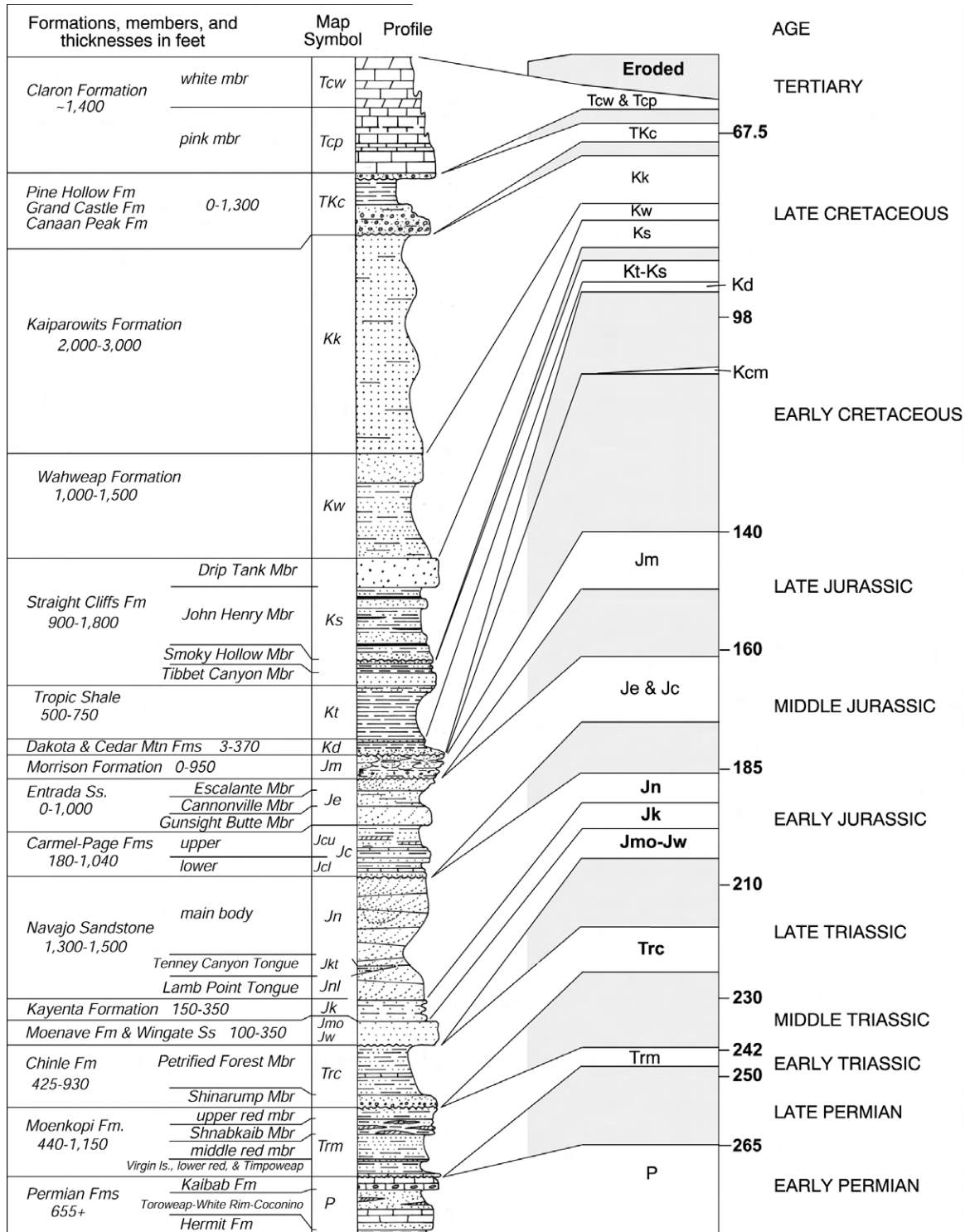


Figure 3. Age, thickness, and names of formations and members of geologic units in and seen from vantage points in the Grand Staircase-Escalante National Monument. Symbols are those used on the geologic maps shown in figures 6, 8, and 10. Profile-lithology plot shows true relative thickness (averages) as compared with the schematic geologic time chart. Gray areas on schematic time chart denote time with missing rock records. Not all of the members of formations or equivalent formations are shown on this chart. Please refer to Hintze (1988). Numbers between period designations indicate age of time boundary based on the time scale of Haq and Van Eysinga (1987).

Middle to Late Jurassic time in the monument is mostly represented by the Carmel and Entrada Formations. The Carmel was deposited near the south margin of a shallow sea that advanced into the area from the north. The complex and interfingering relationships between marine, marginal marine, and non-marine beds are well exposed in the monument (figure 4). Desert sand dunes to beach and back-beach sands of the Entrada Sandstone were deposited on Carmel Formation in the wake of the retreating Carmel sea. Another 3 to 5 million years elapsed between the time the sands of the Entrada Sandstone were deposited and Upper Jurassic Morrison Formation sediments were laid down. In the

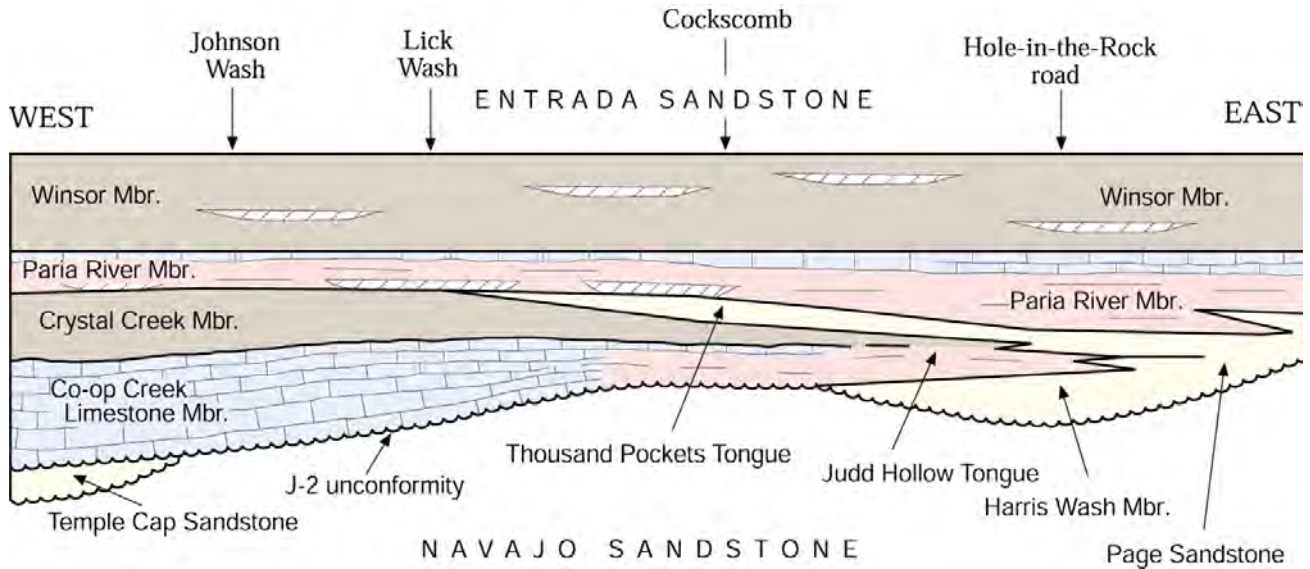


Figure 4. Schematic diagram showing the Carmel-Page relationships from west to east across the Grand Staircase-Escalante National Monument (not drawn to scale).

Escalante Canyons section, the Morrison was deposited by northeast-flowing streams. The sluggish meandering and anastomosing streams of Morrison time developed broad flood plains.

Late Jurassic to early Tertiary compressive forces in the Earth's crust formed high mountain ranges in western Utah and eastern Nevada, which peaked in the Late Cretaceous. This mountain-building event is known as the Sevier orogeny. Simultaneously, a Late Cretaceous epicontinental sea spread to the foot of these mountains and inundated the monument area. The sea covered most of the interior of the North American continent from the Arctic Ocean to the Gulf of Mexico, dividing the continent into two parts. At its maximum extent, the sea stretched to the Cedar City area in southwest Utah, west of the monument. Sediment, provided by the erosion of the Sevier mountains, was carried eastward by rivers and streams to the sea. Dakota Formation sediment was deposited in coastal areas ahead of the encroaching sea. The Tropic Shale represents mud deposited at the bottom of the sea; the Straight Cliffs Formation was deposited in marine to nearshore environments; the Wahweap and Kaiparowits Formations represent sediments deposited on a piedmont belt between the mountains and the sea after the sea retreated east of the monument area.

The west part of the monument area was elevated before sediments were deposited during the transgressive and regressive stages of this epicontinental sea. In the west part of the monument, a good part of the Middle Jurassic and all Upper Jurassic rocks were removed by erosion before the Cretaceous sediments were deposited (see figure 3).

The thickness, continuity, and broad temporal distribution of the Cretaceous rocks exposed on the Kaiparowits Plateau provide opportunities to study marine to non-marine depositional environments.

The Canaan Peak Formation straddles the boundary between Cretaceous and Tertiary time. Dinosaurs became extinct during its deposition and changes in depositional environments followed. The Sevier mountains to the west were gradually removed by erosion by early Tertiary time and several large lakes occupied areas extending from southwestern Wyoming to southwestern Utah. The Claron Formation, which forms the Pink Cliffs at Powell Point and Bryce Canyon National Park, was deposited in lakes, marshes and alluvial plains that covered much of the monument area.

Much volcanic activity took place in central Utah in middle Tertiary time. Today, volcanic rocks cap the Aquarius Plateau and Boulder Mountain north of the monument, and volcanic boulders litter benches in the north part of the Escalante Canyons section. All during the middle Tertiary, Utah and surrounding areas lay at low elevations not far above sea level. A general rise of the landscape and tectonic activity (faulting) occurred throughout Tertiary time and continues into the present. In the late Tertiary in western Utah, faulting brought on by crustal extension (stretching) formed grabens, horsts, and tilted fault blocks that form the north-south-trending basins and ranges in western Utah and Nevada. The monument is located at the east edge of the Basin and Range Province, and the Johnson Canyon and Paunsaugunt faults are the easternmost of the basin and range faults. Although detailed fault and seismic studies are lacking, the Johnson Canyon and Paunsaugunt faults may be active and may relate to small earth tremors and earthquakes that have been experienced in the area (University of Utah Seismology Catalog, 1986; Doelling and Davis, 1989). Uplift of the Grand Canyon area occurred simultaneously with the general Colorado Plateau uplift, and its specific effect extends into the monument area as the Kaibab uplift (Lucchitta, 1972; McKee and McKee, 1972).

The Colorado Plateau is still rising, and the Colorado River and its tributaries continue to cut deep canyons into the landscape and into the colorful formations deposited in late Paleozoic and Mesozoic time. The basin-and-range faults continue to move and affect the Grand Staircase section of the monument. The unconsolidated fluvial and wind-blown deposits that are temporarily lodged in the hollows of the eroding formations while on their way to the ocean, hold the secrets of the past few million years, and most of the evidence of human habitation during the past few thousand years.

## SECTIONS OF THE MONUMENT

The monument may be divided into three broad areas. From west to east these are the Grand Staircase, Kaiparowits Basin, and Escalante Canyons sections (figure 2). **The Grand Staircase section** is a broad area that encompasses the western third of the monument, and consists of a series of topographic benches and cliffs that, forming a “Grand Staircase” as its name implies, step progressively up in elevation from south to north. The risers correspond to cliffs and the steps correspond to the broad benches, terraces, or plateaus in the staircase (figures 5 and 6). The bottom of the staircase commences at the top of the Kaibab uplift, which correlates with and is in the same stratigraphic position as the highest bench of the Grand Canyon in Arizona. The first riser above this bench is the Chocolate Cliffs,

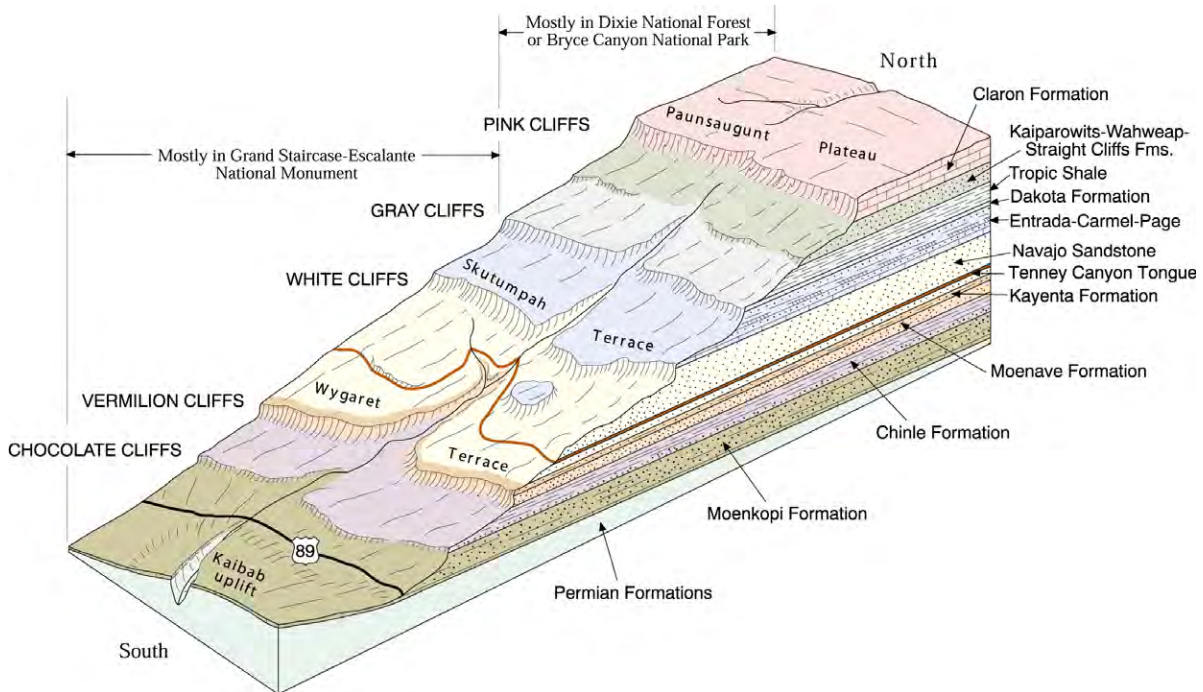


Figure 5. Diagrammatic block diagram of the Grand Staircase section of the monument. Strata dip generally northward. See Doelling and Davis (1989) for technical discussion.

which are not well developed in the Grand Staircase section and consist of the upper red member of the Lower Triassic Moenkopi Formation capped by the Upper Triassic Shinarump Member of the Chinle Formation. Discontinuous Shinarump outcrops explain why this riser is not well developed in the monument. The next step is known as the Shinarump Flats. This bench is mostly developed on top of the hard Shinarump Member and in the overlying soft Petrified Forest Member of the Chinle Formation. The Vermilion Cliffs form the next riser, which is well developed in the monument. The cliffs are made up of the resistant red sandstone beds of the Lower Jurassic Moenave and Kayenta Formations. The Wygaret Terrace forms the next step and includes the soft upper part of the Kayenta and the lower part of the Lower Jurassic Navajo Sandstone. The imposing White Cliffs form the next riser and consist of the upper part of the Navajo Sandstone and the Middle Jurassic Co-op Creek Limestone Member of the Carmel Formation. The bench on this riser is the Skutumpah Terrace built on the remaining soft parts of the Carmel Formation and the overlying Entrada Sandstone. The Gray Cliffs are a series of low cliffs formed by hard Cretaceous sandstone beds. Several benches have formed between these cliffs in the softer shale beds and sandstones of the Tropic, Straight Cliffs, Wahweap, and Kaiparowits Formations. The final riser, mostly north and west of the monument, in Dixie National Forest and Bryce Canyon National Park, is formed by the Pink Cliffs. The Pink Cliffs consist of lower Tertiary limestones and marls that are sculpted into the beautiful natural features found in Bryce Canyon. The cliffs culminate as the Paunsaugunt Plateau, which is the uppermost bench or step of the “Grand Staircase.”

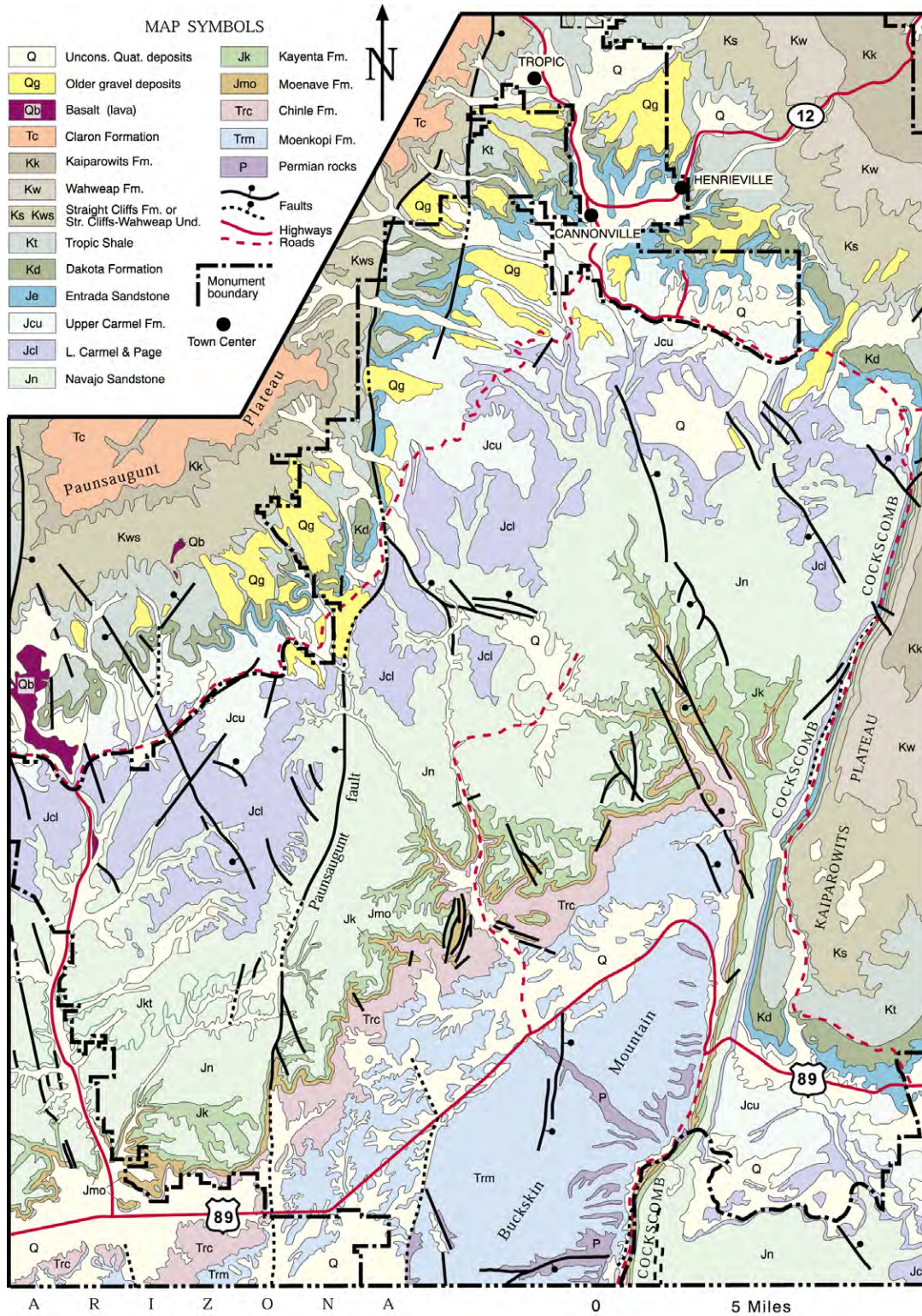


Figure 6. Generalized geologic map of the Grand Staircase section of the monument. The “Grand Staircase” is named for a series of cliffs. The lowermost Chocolate Cliffs are aligned along the Moenkopi-Chinle (Trm-Trc) contact; the Vermilion Cliffs are aligned along the Moenave-Kayenta (Jmo-Jk) outcrops; the White Cliffs are aligned along the upper third of the Navajo Sandstone (Jn); the Gray Cliffs are here aligned along the Dakota Formation (Kd); and the highest Pink Cliffs are aligned just above the Kaiparowits-Claron (Kk-Tc) contact.



The boundary between the Grand Staircase and Kaiparowits Basin sections is The Cockscomb, a series of hogbacks along the East Kaibab monocline, where strata are folded sharply downward to the east. The Cockscomb trends approximately N. 20° E. from the Arizona border to Grosvenor Arch as a sharp fold in the strata. Dips diminish and become more gentle as the trend wraps northwesterly north of the towns of Henrieville, Cannonville, and Tropic. The character of rocks stratigraphically higher than the Tropic Shale in the Grand Staircase section is like that in most of the Kaiparowits basin section and should be considered a part of that section.

**The Kaiparowits basin section** is centrally situated in the monument and is mostly exemplified by the Kaiparowits Plateau. Doelling and Davis (1989) described this section as "a series of plateaus, buttes, and mesas carved in Cretaceous rocks that reflect the structures of the underlying geologic strata." The Kaiparowits basin covers about 1,650 square miles in the central part of the monument (figures 7 and 8). The feature is a broad geologic structural basin; however, the topographic expression is that of a northward-tilted, highly dissected plateau that has been modified by generally north-south-trending folds. The Aquarius and Table Cliff plateaus lie northward and topographically above the Kaiparowits Plateau.

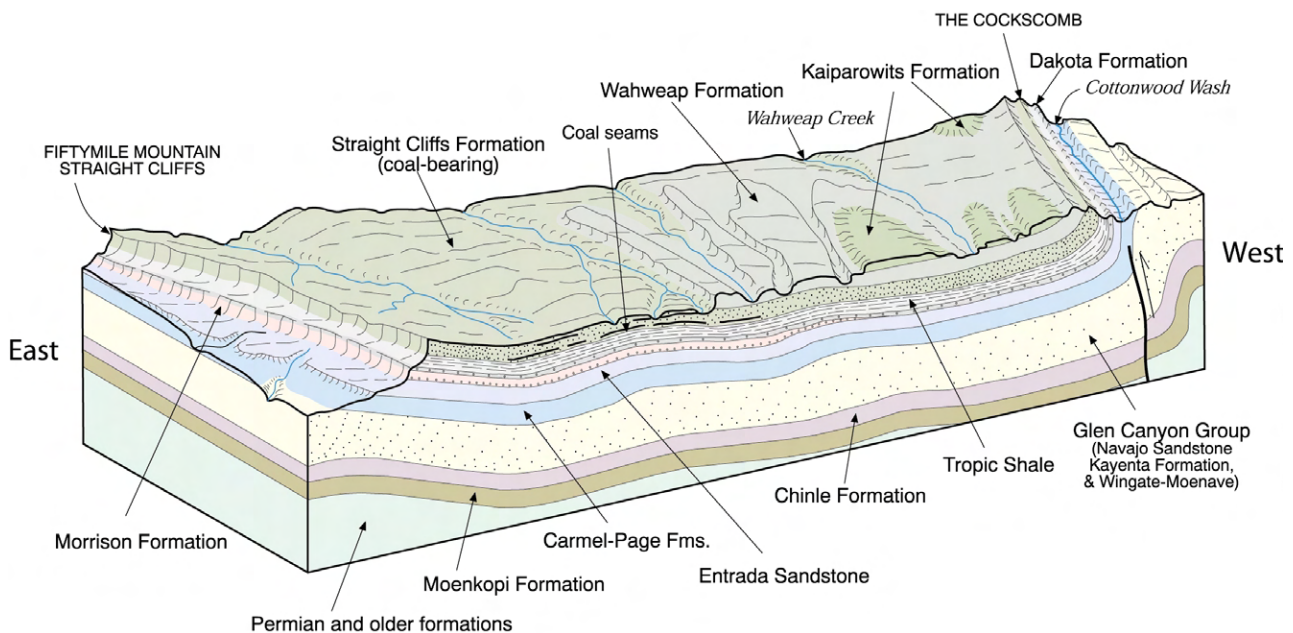
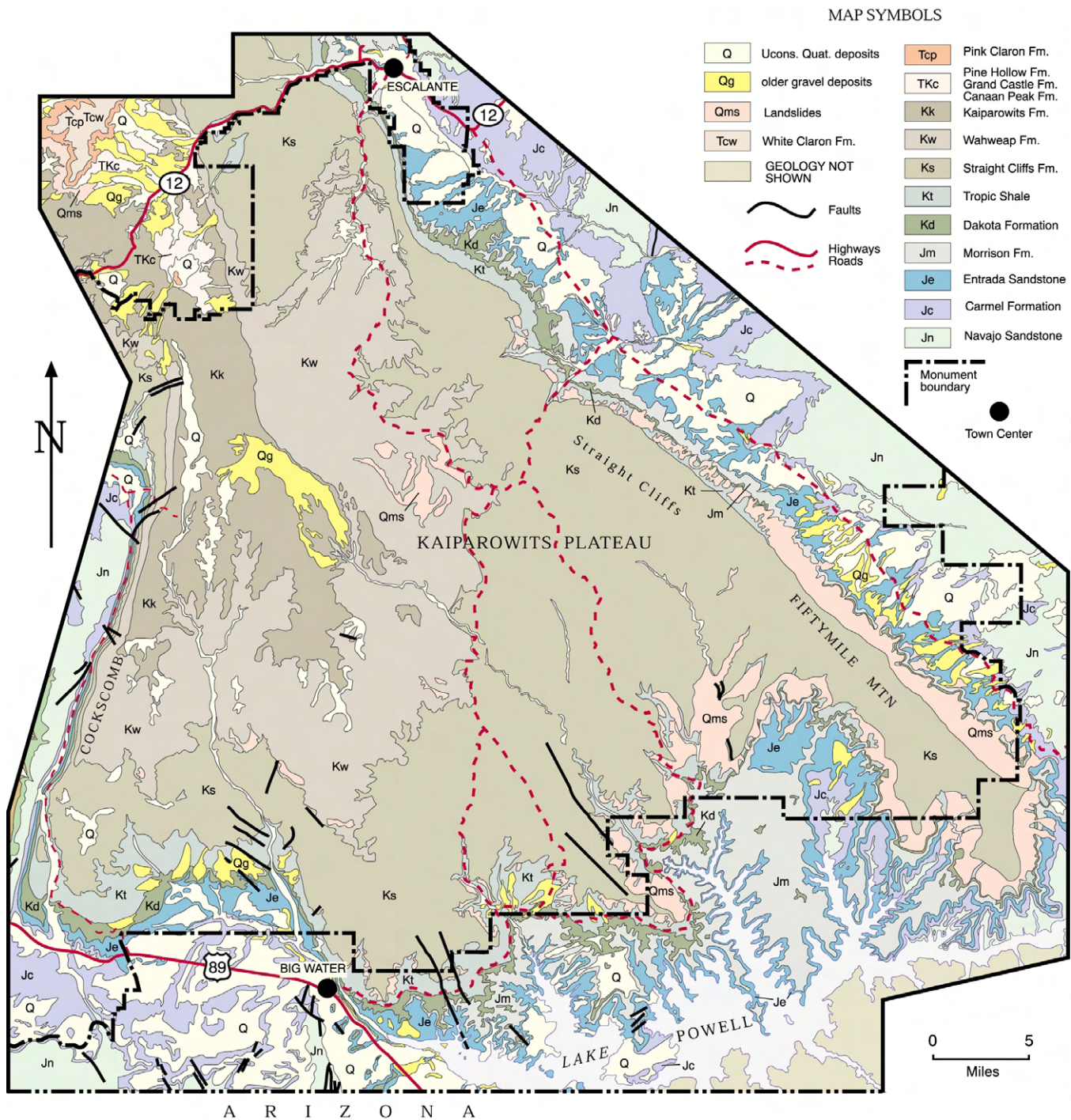


Figure 7. Diagrammatic block diagram across the Kaiparowits basin section of the monument. View is from the north looking south. The deepest part of the basin is aligned north-south along Wahweap Creek. The strata dip generally northward, but north-south-trending anticlines and synclines warp the block. The Straight Cliffs mark the east boundary and the Cockscomb marks the west boundary of the section.

The Kaiparowits Plateau is defined by the exposed base of the Cretaceous Cedar Mountain and Dakota Formations (Hettinger and others, 1996). It is bounded by the Straight Cliffs, which form a prominent escarpment that rises 1,100 feet or more and extends for more than 50 miles northwest to southeast above the Dakota and Tropic Formations. The cliffs roughly mark the plateau's northeast boundary with the Escalante Canyons section of the monument. Some Jurassic strata are exposed in the Kaiparowits basin section of the monument, along its southern boundary, below the Cretaceous cliffs. These Jurassic rocks have a "Canyonlands" character and, indeed, make up the canyonlands above Glen Canyon of the Colorado River.



MAP SYMBOLS

- |  |                       |  |                     |
|--|-----------------------|--|---------------------|
|  | Ucons. Quat. deposits |  | Pink Claron Fm.     |
|  | older gravel deposits |  | Pine Hollow Fm.     |
|  | Landslides            |  | Grand Castle Fm.    |
|  | White Claron Fm.      |  | Canaan Peak Fm.     |
|  | GEOLOGY NOT SHOWN     |  | Kaiparowits Fm.     |
|  | Faults                |  | Wahweap Fm.         |
|  | Highways              |  | Straight Cliffs Fm. |
|  | Roads                 |  | Tropic Shale        |
|  | Monument boundary     |  | Dakota Formation    |
|  | Town Center           |  | Morrison Fm.        |
|  |                       |  | Entrada Sandstone   |
|  |                       |  | Carmel Formation    |
|  |                       |  | Navajo Sandstone    |

Figure 8. Generalized geologic map of the Kaiparowits basin section of the monument. This section represents a large structural basin, but is topographically high. Part of the Escalante Canyons section is represented northeast of Fifty Mile Mountain.

**The Escalante Canyons section** provides a web of multi-hued, steep, narrow canyons and "slick rock," sculpted in the drainage basin of the Escalante River (figures 9 and 10). The section is bounded on the southwest by the Straight Cliffs, on the north by the Aquarius Plateau and Boulder Mountain, on the east by the Waterpocket Fold, and on the south by Glen Canyon of the Colorado River. The Escalante Canyons section can be subdivided into two landscapes based on physiography: Escalante canyons and benchlands, and the Circle Cliffs uplift. The latter is a large doubly plunging anticline, the core of which is eroded into a large kidney-shaped physiographic basin surrounded by a set of imposing vertical Wingate Sandstone cliffs.

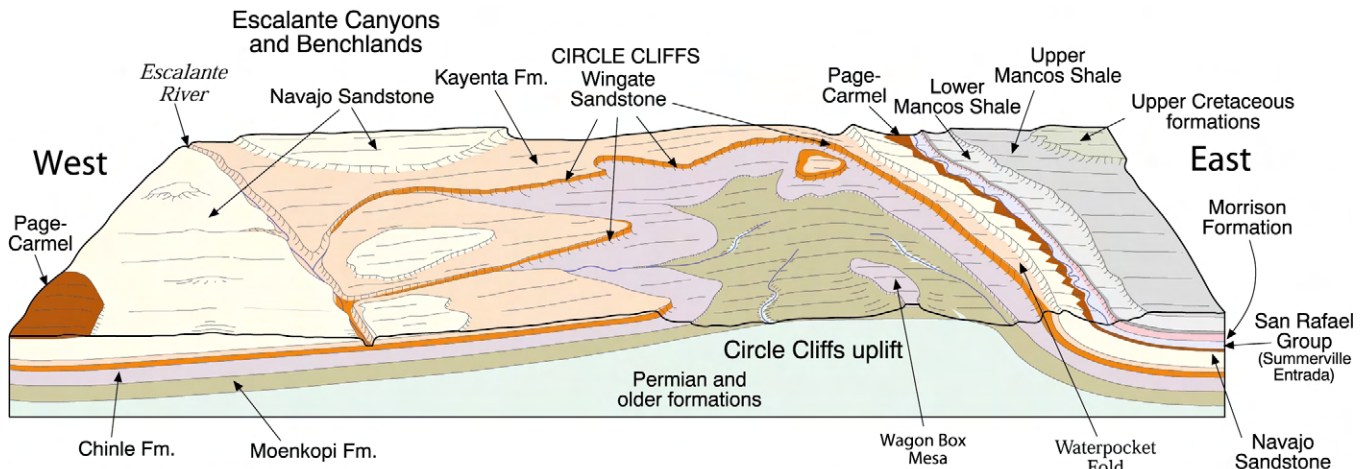


Figure 9. Diagrammatic block diagram across the Escalante Canyons section of the Monument. This section consists of two parts: to the west is the Glen Canyon Group bench-and-canyonlands country incised by the Escalante River and its tributaries. To the east is the Circle Cliffs uplift, a large, plunging, north-south-trending anticline that exposes a "fossil" oil field in its core. The steeply dipping Waterpocket Fold makes up the east boundary of the uplift and is mostly in Capitol Reef National Park.

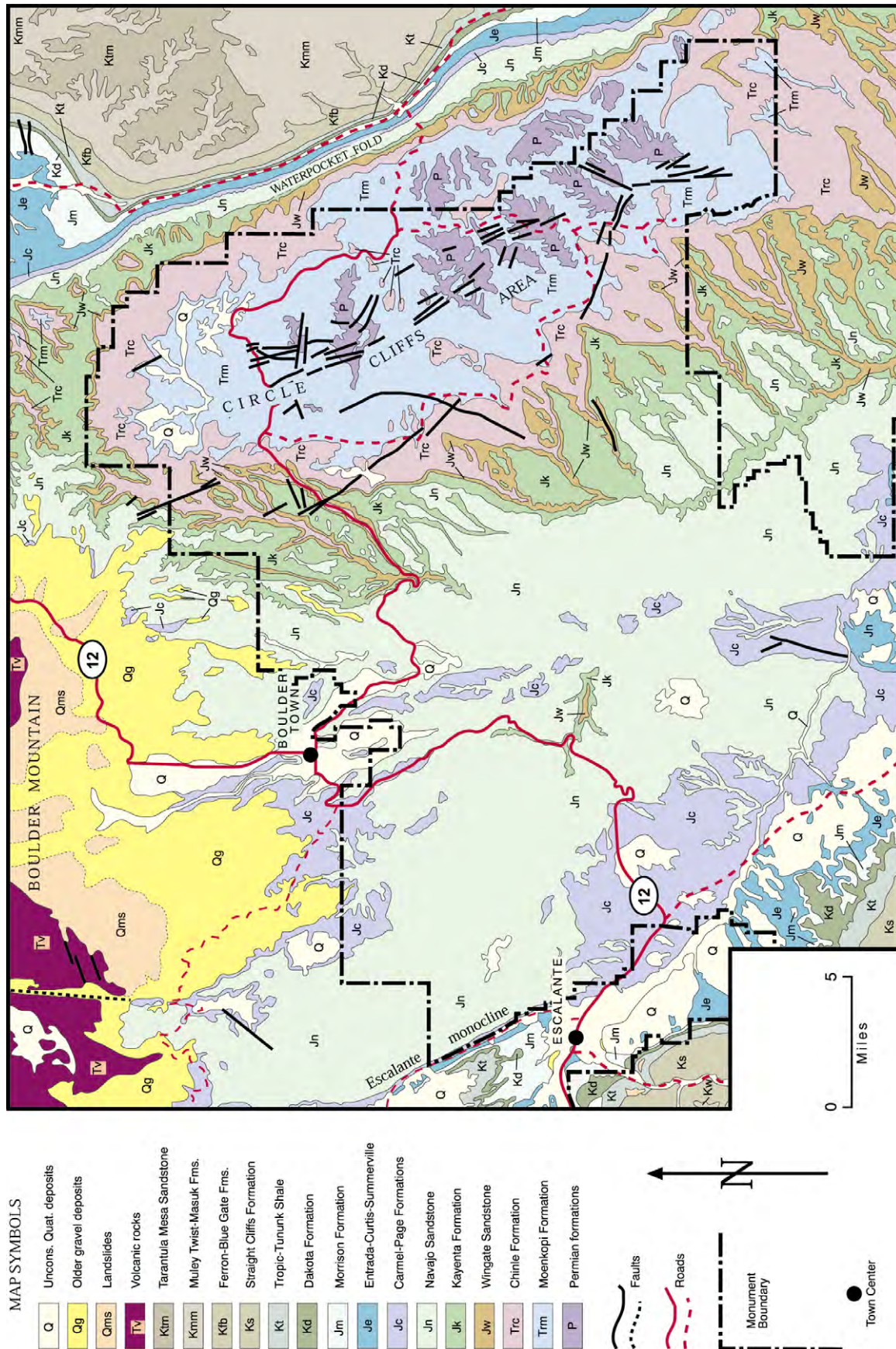


Figure 10. Generalized geologic map of the Escalante Canyons section of the monument. This section is composed of two parts: the Circle Cliffs area to the east, which is partly formed by the Waterpocket Fold in Capitol Reef National Park, and the bench-and-canyonlands country to the west that is dominated by exposures of the Navajo, Kayenta, and Wingate Formations.

## HOLE-IN-THE-ROCK-ROAD

This geologic road guide is along a county road that may be very rough, depending upon how recently maintenance has been performed. It is commonly washboarded and, as one approaches Hole-in-the-Rock above the Colorado River Canyon, the road is very rough and requires a high-clearance vehicle. Generally, the Garfield County portion of the road is in better condition than the Kane County portion. To run the full road guide generally takes three hours in one direction. If the traveler wishes to take pictures and examine outcrops, this trip can easily take all day. The distance to Hole-in-the-Rock, without side trips is about 53 miles. Carry sufficient water and gasoline for the trip.

This guide commences at the junction of Utah State Highway 12 and the Hole-in-the-Rock road and generally runs as far as the Colorado River and Lake Powell parallel to the pioneer trail established by Mormon Pioneers leading an expedition from Escalante to Bluff in 1888. This guide describes the roadside geology rather than the historical aspects of the route.

<b>MILEAGE INTERVAL/CUMULATIVE</b>	<b>DESCRIPTION</b>
0.0    0.0	Junction Utah State Highway 12 and the Hole-in-the-Rock road, about 6 miles southeast of the town of Escalante. The Hole-in-the-Rock road continues southeasterly whereas Utah State Highway 12 heads northeastward toward the town of Boulder.
0.3    0.3	Junction with triangle road entering from the northeast. <b>Continue straight ahead.</b> The road to the northeast joins with Utah State Highway 12 in about 0.2 miles.
0.5    0.8	The road is now near the top of the Paria River Member of the Middle Jurassic Carmel Formation. The rock is a yellow-gray or tan platy limestone.
1.5    2.3	Reddish rocks with thin gypsum beds are Winsor Member of the Carmel Formation.
1.2    3.5	Orange-brown, bare-rock, massive sandstone outcrops to right are Gunsight Butte Member of the Middle Jurassic Entrada Sandstone.
0.7    4.2	Cross Tenmile Wash (Alvey Wash).
0.1    4.3	To right is a nicely exposed outcrop of the Winsor Member of the Carmel Formation, with thin gypsum beds and criss-crossing veinlets of gypsum.
0.2    4.5	A 4- to 5-foot white alabaster gypsum bed is immediately to the right of the road. The road now rises out of the wash bed, up and through the Winsor Member onto a bench of Pleistocene and Holocene mixed eolian and alluvial deposits (Qea).

- 0.3 4.8 Cross Cottonwood Wash and drop through Qea deposits resting on the Gunsight Butte and Cannonville Members of the Entrada Sandstone.
- 1.5 6.3 Cross Half-Way Hollow, which also shows Qea deposits resting on the Cannonville and Gunsight Butte Members of the Entrada Sandstone.
- 2.3 8.6 Harris Wash Junction. **Keep right on the Hole-in-the-Rock road.** To the right, in the middle distance, are outcrops of light-yellow sandstone of the Escalante Member of the Entrada Sandstone overlain by a slope of reddish Tidwell Member of the Upper Jurassic Morrison Formation, which in turn is overlain by the clifty and ledgy conglomeratic sandstones of the Salt Wash Member of the Morrison Formation. Harris Wash is a tributary of the Escalante River. The road leads to a trail to the Escalante River Canyon.
- 1.6 10.2 Junction, **turn right** 90 degrees (southwest) to Devils Garden.
- 0.3 10.5 **STOP 1.** Devils Garden. Get out of the vehicle and take a short hike to see the goblins and a fabulous natural arch eroded from rocks at the top of the Gunsight Butte Member of the Entrada Sandstone. Looking west the slope-forming red-brown outcrops to the light-yellow sandstone are Cannonville Member of the Entrada. The light-yellow bare-rock sandstone outcrops at the foot of the cliff are Escalante Member of the Entrada Sandstone. The entire Entrada Sandstone is about 900 feet thick here. The reddish slope overlying the Escalante Member is the Upper Jurassic Tidwell Member of the Morrison Formation. It has been previously mapped as Middle Jurassic Summerville Formation; however, these beds are Late Jurassic in age and intertongue with conglomeratic sandstone beds of the Salt Wash Member of the Morrison. The ledgy sandstones that overlie the Tidwell here are Salt Wash Member of the Morrison Formation. (Restroom facilities are available here). **After stop return to the Hole-in-the-Rock road.**
- 0.3 10.8 Hole-in-the-Rock road. **Turn right** (southeast).
- 0.8 11.6 The road drops into a draw where reddish rocks are covered with orange-brown wind-blown sand deposits. The Entrada, upon weathering, produces much sand that covers many of its outcrops. Outcrops of the Gunsight Butte Member, the Winsor Member, and Qea deposits appear under the sand.
- 0.8 12.4 Collet Top Junction. **Continue on the main road (left).**
- 0.5 12.9 Cross Twentymile Wash. Other than the alluvium of the wash, the road is in the gypsum-bearing Winsor Member. This wash drains a large part of the Kaiparowits Plateau, emerging from Left and Right Collet Canyons to the west. Terraces containing rounded cobbles of Upper Cretaceous rocks and banded quartzite derived from the Paleocene Canaan Peak Formation are found at various elevations along the wash. Flash floods flow down this drainage following torrential summer rains on the Kaiparowits Plateau, and it is not uncommon for as much as seven feet of water to fill the wash and flow for a day

or two. The road rises out of the wash and onto the Entrada Sandstone and wind-blown sand deposits at the top of the hill.

- 2.4 15.3 **Egypt Junction, keep right on main road.** Enter Kane County on Qea deposits. Egypt is an area of bare-rock Navajo Sandstone and the start of a hike leading to the Escalante River Canyon.
- 0.5 15.8 Cross Rat Seep Hollow. Qea deposits rest on the Cannonville Member (reddish rocks) of the Entrada Sandstone. Road rises up to Sunset Flat developed on Qea deposits.
- 1.0 16.8 **STOP 2.** Sunset Flat panorama. To the southwest (right) is White Point with the Escalante Member of the Entrada Sandstone at the base, the reddish Tidwell Member of the Morrison Formation forming a slope, and the Salt Wash Member forming a stair-step ledgy cliff above. Behind White Point are Fiftymile Mountain and the Straight Cliffs, here forming an unbroken line of cliffs for thirty miles down to Hole-in-the-Rock. Most of the Fiftymile Mountain cliff face is John Henry Member of the Upper Cretaceous Straight Cliffs Formation, here represented by thick beach sandstone beds separated by muddy sandstone deposited in a shoreline environment. The John Henry contains thick coal deposits (lagoonal deposits) several miles farther southwest. The base of the Straight Cliffs Formation consists of two members, the Smoky Hollow Member resting on the Tibbett Canyon Member. The Tibbett Canyon Member consists of offshore sandstones and the Smoky Hollow Member consists of back-beach and lagoonal deposits. Coaly beds in the Smoky Hollow Member are generally thin. The Smoky Hollow Member is separated from the overlying John Henry Member by a regional unconformity. Below the Straight Cliffs Formation is the Tropic Shale, a gray muddy formation that contains marine fossils deposited in the Upper Cretaceous Interior Seaway. At its base is thin Dakota Sandstone, which locally contains some thin coal deposits. The Upper Cretaceous Dakota Sandstone rests unconformably on the Salt Wash Member of the Morrison Formation in this area.

To the left (northeast) Boulder Mountain is on the skyline. In the middle ground is the trough of the Red Breaks syncline plunging toward the south. To the left of the syncline is the Collet anticline. Also to the left, but looking east in the far distance, the three highest peaks of the Henry Mountains may be seen on the skyline, from north to south, Mt. Ellen, Mt. Pennell, and Mt. Hillers. Also a gunsight butte can be seen at the south end of the Circle Cliffs uplift.

- 3.7 20.5 **STOP 3.** Straight Cliffs viewpoint. Stop at marker reference 35, route 1862. Looking southwest immediately to the right of the road is a nice exposure of the Gunsight Butte Member of the Entrada Sandstone. Nice exposures of Qea deposits are found in the wash beyond. For those interested in the Quaternary, a hike here will be rewarding. The Qea deposit exhibits channeling, gravels sourced in Cretaceous rocks, partly consolidated sands sourced from the Entrada Sandstone, and a thick caliche deposit near the top. The Qea deposit is at least

80 feet thick. The Straight Cliffs are nicely exposed here and the traveler should review the stratigraphy given at stop 2. The Tropic Shale, which is generally covered by landslides, is better exposed here. It should be noted that the Tidwell Member is now gone, all having been replaced by the Salt Wash Member of the Morrison Formation. The Escalante Member of the Entrada Sandstone has nearly disappeared and is not identifiable farther to the southeast.

- 1.0 21.5 To the northeast is a view of the Gunsight Butte Member contact with the underlying Winsor Member of the Carmel Formation.
- 0.4 21.9 The white material in the road is alluvial gypsum, reworked from the gypsum beds in the Winsor Member.
- 0.5 22.4 Cat Pasture (Cottonwood trees). Note the junction to Early Weed Bench. **Continue on the main road.** The road to Early Weed Bench affords good exposures of the Winsor Member, Paria River Member, and the Page Sandstone, and provides hiking access to the Navajo Sandstone and Escalante River Canyon.
- 0.4 22.8 As the road rises out of Cat Pasture, look left at about 11 o'clock. The red slope of the Paria River Member rests on red-brown Harris Wash Member of the Middle Jurassic Page Sandstone. This member resembles the massive bare rock outcrops of the Lower Jurassic Navajo Sandstone below, but it is generally a bit darker than the Navajo. It is separated from the Navajo by a regional unconformity.
- 0.1 22.9 White chippy limestone on right marks the top of the Paria River Member of the Carmel Formation.
- 0.2 23.1 To the left note high-angle cross-beds in the Navajo Sandstone capped by the flat-bedded Page Sandstone, in turn overlain by the red slope of the Paria River Member. The road rises onto Black Ridge (Qea deposits).
- 1.0 24.1 To the left note contorted gypsum-bearing Winsor Member above the deeper red of the Paria River Member.
- 0.6 24.7 Dry Fork Trailhead junction veering left, **stay on main road.**
- 2.5 27.2 Exposed is the Paria River Member of the Carmel Formation. Note the gravel deposits containing Cretaceous sandstone cobbles and fragments forming a cover over the member.
- 0.5 27.7 Cross Big Hollow Wash. Can you pick the Page-Navajo contact here?
- 1.0 28.7 More gravel deposits, which cover the Gunsight Butte Member of the Entrada Sandstone.



- 0.2 28.9 Purplish bed in road is a volcanic ash in the Entrada.
- 0.6 29.5 Redwell Junction veering left, **continue on the main road** in Qea.
- 0.4 29.9 Reference marker 50, cross wash. Corral and building on left.
- 1.9 31.8 Junction with the Chimney Rock Road veering left. **Continue on the main road.** Chimney Rock is a spire or monolith of Gunsight Butte Member of the Entrada Sandstone that stands about 45 feet high. This side trip requires a four-wheel-drive vehicle because of loose sand.
- 0.7 32.5 Willow Tank. Lots of Gunsight Butte Member exposed here; note bleached sandstone near the springs. Cross Hurricane Wash. Note the gravel-topped hills as you rise from the wash.
- 0.5 33.0 Junction with Fiftymile Bench Road. **Stay on the main road** on Qea deposits. Note the large landslides "pouring down" into the reentrants over the Morrison Formation cliff. The Fiftymile Bench Road uses a landslide to rise onto Fiftymile Bench. Fiftymile Bench is formed on the top of the Morrison Salt Wash Member, the Dakota Sandstone, the Tropic Shale, and more landslides. Views from the bench are spectacular.
- 0.7 33.7 Cross a southern branch of Hurricane Wash, mostly through the Gunsight Butte Member of the Entrada Sandstone, which is somewhat contorted here over the Winsor Member of the Carmel Formation.
- 1.2 34.9 Junction with Fortymile Ridge Road veering left. **Stay on main road.** A nice view of a landslide can be seen in the Right Fork reentrant to the right (southwest). In the middle ground to the right is a point, which (in ascending order) exposes the Gunsight Butte Member and Cannonville Member of the Entrada Sandstone, the Romana Sandstone, and stair-step ledges of the Salt Wash Member of the Morrison Formation.
- 0.8 35.7 Dance Hall Rock to the left. This natural amphitheater is carved in the Gunsight Butte Member of the Entrada Sandstone. The pioneers stopped here on the way to Bluff from Escalante, made camp at a nearby spring, and held square dances in the amphitheater. It was the end of the easy part of their trip.
- 0.7 36.4 Junction with the road to Fortymile Spring veering left. **Stay on main road.**
- 1.3 37.7 To the right, the thin light-colored sandstone above the reddish Cannonville-Entrada on the cliff is the Romana Mesa Sandstone. At the top of the cliff is the ledgy Salt Wash Member of the Morrison Formation.
- 0.6 38.3 The road drops into Carcass Wash, which is lined with the Gunsight Butte Member. The monument in the wash commemorates the death of 13 scouts and scouters that were killed when their pickup overturned after the brakes failed on

June 10, 1963.

- 1.0 39.3 Reference marker 65. Enter Sooner Wash. The contact between the Gunsight Butte Member of the Entrada and the Winsor Member of the Carmel Formation is exposed in the wash. To the right are the Sooner Rocks (Entrada Sandstone).
- 0.2 39.5 Cross Sooner Wash; note the zebra-striped Entrada on the far side and the uneven nature of the Carmel-Entrada contact. The road rises onto Sooner Bench with Qea deposits.
- 1.8 41.3 Cross gulch exposing the Carmel Formation.
- 0.5 41.8 Drop into Sooner Gulch (not Sooner Wash) exposing outcrops of the Entrada and Carmel Formations. Notice the bouldery gravels on top.
- 0.2 42.0 Cross Sooner Gulch and notice the undulatory Entrada-Carmel contact as you rise out of the gulch on the left.
- 0.3 42.3 Junction with another Fiftymile Bench Road veering to the right; **keep left on the main road.** Nice view of the landslides draping over the Salt Wash Morrison on the right.
- 0.9 43.2 Cross gulch in the Carmel Formation.
- 0.4 43.6 Look for hoodoos in landslides to the right.
- 0.2 43.8 Enter Glen Canyon National Recreation Area.
- 0.7 44.5 Notice pediment gravel on an old surface built on the Entrada Sandstone.
- 0.5 45.0 Good view of the Page-Navajo contact to the left. The brown sandstone is the Page and the underlying pink-gray sandstone is the Navajo. The Page here is mostly eolian and cross-bedded, as is the Navajo.
- 0.1 45.1 Cross The Soda gulch in the Carmel Formation.
- 0.5 45.6 Note the several hoodoos directly ahead in the landslide above the Gunsight Butte Member of the Entrada Sandstone.
- 0.9 46.5 The point ahead exposes the Entrada, Romana, and Morrison Formations in ascending order. The Romana Sandstone is separated from the Entrada and Morrison by unconformities. In erosional habit it is like the Entrada, forming a vertical cliff. It is the thin light-colored interval at the top of the Entrada Sandstone. The hoodoos developed in the landslide debris are now to the right.
- 0.2 46.7 Cross gulch with Paria River Member of the Carmel Formation resting on the Page Sandstone.

- 0.9 47.6 Navajo Mountain may now be seen in the distance to the south. The road drops through the Paria River Member of the Carmel Formation onto the Page Sandstone and then onto the Lower Jurassic Navajo Sandstone. The Page-Navajo contact is nicely exposed here and can be identified between the light-hued checkerboard Navajo Sandstone and the slightly darker Page Sandstone. A careful look above, at the previous point in the Salt Wash Member of the Morrison Formation, reveals a small arch. From here it is absolutely necessary to have a high-clearance vehicle (unless the road has been repaired since this road guide was written).
- 1.2 48.8 Flat, lavender rock at right is a limestone bed in the Navajo Sandstone and represents a playa lake or oasis in Navajo time. The road proceeds on bare rock outcrops—watch out for points, rocks, and bumps that can high-center your vehicle.
- 0.2 49.0 The road rises onto the limestone ledge. The road improves a bit courtesy of the ledge.
- 0.2 49.2 Plaque alerts one to the presence of the Hole-in-the-Rock arch, which is the same arch referred to at mile 47.6. It can be seen at the top of the point to the right. A full view of Navajo Mountain is available around the corner.
- 3.7 52.9 Rise onto another limestone ledge in the Navajo Sandstone.
- 0.4 53.3 **STOP 4.** End of the road. A short hike will bring you to an overlook of Lake Powell and the Hole-in-the-Rock, where pioneers carved steps into the sandstone to lower their wagons down to river level. Unless you have a boat waiting for you, you must turn around and return on the road you came in on.

**END OF ROAD GUIDE**

## CIRCLE CLIFFS (BURR TRAIL-WOLVERINE LOOP)

This geologic road guide is along county roads that are locally rough, depending upon how recently road maintenance has been performed. Part of the route is on pavement and part is on a gravel road. **The gravel roads should not be traversed after heavy rains.** Although four-wheel drive is not necessary, the gravel roads are best traversed in a high-clearance vehicle. To run the full road guide (54 miles) generally takes three hours. If the traveler wishes to take pictures and examine outcrops, this trip can easily take all day. Carry sufficient water and gasoline for the trip.

This guide commences at the junction of Utah State Highway 12 and the Burr Trail county road in the town of Boulder.

MILEAGE INTERVAL/CUMULATIVE	DESCRIPTION
0.0    0.0	Junction with Utah State Highway 12 and the Burr Trail Road (Burr Trail Junction), in the middle of the town of Boulder, Utah. The junction is at a bend in Utah State Highway 12, and the Burr Trail Road begins in an easterly direction.
1.3    1.3	Road passes outcrops of bare-rock Navajo Sandstone; the checkerboard pattern characteristic of the Navajo Sandstone is evident for the next few miles.
5.2    6.5	The road crosses Deer Creek in the pink Navajo. This is a perennial stream.
3.3    9.8	<b>STOP 1.</b> The Gulch and Long Canyon overlook. The overlook is on the Kayenta Formation; the canyons below are cut into the Wingate Sandstone. Both Long Canyon and The Gulch are tributaries of the Escalante River and both head in the Circle Cliffs area. In contrast to Deer Creek, the drainages here are intermittent. Nevertheless, they commonly carry dangerous flash floods. From this point, the road descends into The Gulch and then proceeds up Long Canyon into the Circle Cliffs area.
0.6    10.4	The road has now descended into The Gulch, the walls of which are of the Wingate Sandstone. Note the thick alluvial remnants that are now being removed.
0.6    11.0	The road turns into Long Canyon where the canyon walls for the next few miles are Wingate Sandstone. Notice the joints and rock falls.
1.4    12.4	Outcrops of the Chinle Formation appear at the base of the Wingate Sandstone.
2.8    15.2	In this area of the canyon, the Wingate becomes highly jointed and is bleached.
1.9    17.1	<b>STOP 2.</b> Land of the Sleeping Rainbow overlook. This is a beautiful place to see the variegated slopes of the upper Chinle Formation. The brightly colored slopes reminded the American Indian of a rainbow. The lower Chinle Formation

here is known as the Shinarump Member and is a conglomeratic cliff and bench former. One can look across the Circle Cliffs anticline from this point. The Circle Cliffs uplift gets its name from the in-facing Wingate Sandstone cliff. In the center of the uplift buttes of the Shinarump Member are aligned in the direction of paleochannels. The Wingate cliffs above the Chinle Formation are bleached in this area. The bleaching is thought to be due to hydrocarbons that were present in the rock.

- 0.7 17.8 The road drops through the Shinarump cliff in the Moenkopi Formation outcrops.
- 1.0 18.8 Junction. Road to right (gravel or dirt) continues into Horse Canyon, and is sometimes called the Wolverine Loop Road. The paved road continues left toward the Burr Trail. **Continue right on the Wolverine Loop Road.**
- 4.2 23.0 The Shinarump Member of the Chinle Formation, which is discontinuous in the Circle Cliffs, pinches out on the right side as the road continues in the wash.
- 1.4 24.4 Horse Canyon opens to the right. **Keep left on the road** along which thick Shinarump Member is exposed.
- 0.5 24.9 Note the old abandoned uranium mine to the left at the base of the Shinarump Member.
- 3.1 28.0 The Moenkopi Formation is bleached to a green color beneath the Shinarump Member. Note the old uranium mine roads as we approach Wolverine Canyon.
- 1.0 29.0 The road rises through the Shinarump Member into the upper slope-forming Petrified Forest Member of the Chinle Formation.
- 2.7 31.7 Little Death Hollow, **keep left** and drop back into outcrops of the Moenkopi Formation. Here the normally red-brown or chocolate-brown Moenkopi Formation is bleached to yellow gray.
- 5.7 37.4 **STOP 3.** Moenkopi Formation tar sands. A close look at the Moenkopi Formation just below road level reveals dark-gray bands. Take a short hike and examine these outcrops. The broken surfaces of these rocks are nearly black. Smell the rock for the sweet odor of petroleum. The axis of the Circle Cliffs anticline was once the locus of a giant oil field. Erosion has cut into the oil-saturated sandstone providing the means for the lighter constituents to evaporate, leaving only the heavier tar.
- 1.2 38.6 Moody Creek and Silver Falls Canyon junction. The road to the right gives access to the southern Circle Cliffs area and presents vistas not unlike those along the Wolverine Loop Road. The road also provides access to the Silver Falls Canyon trailhead, which gives access to the canyon of the Escalante River. **Continue straight ahead on the main road.**

- 1.3 39.9 **STOP 4.** Permian rocks. Erosion digs deep into the axial regions of the Circle Cliffs uplift. The oldest rocks exposed are Permian in age and consist here of beach sandstone (White Rim Sandstone) and marine limestone (Kaibab Formation). These appear yellow-gray in outcrop. Spend some time hiking about the blocky beds and see if you can find any marine fossils. Enjoy them, but leave them in place.
- You should be able to pick the boundary between the Moenkopi Formation and the Permian rocks beneath. The road weaves in and out through Permian rocks over the next few miles. The high mesa to the right is Wagon Box Mesa, which straddles the anticlinal axis.
- 3.9 43.8 Corral at a bend in the road.
- 0.6 44.4 Sand pile.
- 1.3 45.7 The road rises stratigraphically back into the Moenkopi Formation.
- 1.2 46.9 Junction with paved Burr Trail Road. End of Wolverine Loop Road. **Turn right toward Capitol Reef National Park along the Burr Trail.**
- 1.7 48.6 Enter Capitol Reef National Park. **Pavement ends and the road gets rough.** The road proceeds down the steep east limb of the Circle Cliffs uplift toward the Waterpocket Fold.
- 2.3 50.9 Peekaboo Arch can be seen in the cliffs to the left of the road.
- 1.2 52.1 **STOP 5.** Burr Trail Overlook. This road is carved into the dip slope of the steeply dipping reddish sandstones of the Kayenta Formation. It and the massive cross-bedded sandstones of the overlying Navajo Sandstone give a spectacular view. To the east are views of Cretaceous rocks containing marine shale and cliff-forming sandstone beds. **After the stop proceed cautiously down the road switchbacks.**
- 1.5 53.6 At the bottom of the dugway the road crosses the Navajo Sandstone into the reddish and gypsiferous Carmel Formation and then into orange-brown sandstone of the Entrada Sandstone. Look to the left and see the other side of Peekaboo Arch.
- 0.4 54.0 Burr Trail "T" Junction. To the left (north), the gravel road continues for 34 miles to the small town of Notom and Utah State Highway 24. To the right (south), the road extends about 29 miles to Utah State Highway 279 five miles north of Bullfrog and Lake Powell.

## END OF ROAD GUIDE

## KANAB TO BIG WATER ALONG U.S. HIGHWAY 89

This geologic road guide is along a paved U.S. highway. It is a much-traveled highway; therefore, the driver will need to maintain steady speeds. It is recommended that someone read the guide for the driver and other riders. For best results and most enjoyment along the highway the reader should read the remarks in advance. If you wish to stop, find a safe place and pull completely off the highway.

This guide commences at the junction of U.S. 89 and U.S. 89a in Kanab and extends eastward toward Page, Arizona. It includes a relatively short side trip into the ghost town area of Paria (Pahrea is the old spelling). The 70 miles covered by this road guide will take about 1 hour and 45 minutes of driving time. Stops and photography will take additional time.

<b>MILEAGE INTERVAL/CUMULATIVE</b>	<b>DESCRIPTION</b>
0.0    0.0	Junction U.S. 89 and U.S. 89a (highway south into Fredonia, Arizona leading to the north rim of the Grand Canyon at a traffic light in south Kanab City. <b>Turn east</b> , U.S. 89 extends easterly from this point.
0.4    0.4	Cemetery left, leave Kanab.
1.5    1.9	Road cut in the Chinle Formation in blue-purple mudstones. Note capping alluvium at the top of the outcrops.
1.0    2.9	For the next several miles the road is laid down on sandy alluvium. To the left are the Vermilion Cliffs. The slope at the base of the cliffs is the Dinosaur Canyon Member of the Lower Jurassic Moenave Formation. Some thin beds of the Whitmore Point Member of the Moenave Formation are at the top of the slope. The orange-brown cliff in the middle is the Springdale Sandstone Member of the Moenave Formation. The ledgy slope above the Springdale Sandstone is the Kayenta Formation. The light-colored sandstone seen locally at the very top is the Lamb Point Tongue of the Navajo Sandstone. There is no Wingate Sandstone in the Vermilion Cliffs. The Wingate correlates with the Moenave Formation and is nearly the same age. To the right is the dip slope of the Chocolate Cliffs (dipping toward us), which is commonly covered with scabs of purplish or variegated Petrified Forest Member of the Upper Triassic Chinle Formation. The Chocolate Cliffs are Lower Triassic Moenkopi Formation overlain by the Shinarump Member of the Chinle Formation. The upper red member of the Moenkopi Formation, which directly underlies the Shinarump, was thought to have a chocolate-brown color. The Shinarump Member is the source of the “Kanab Wonderstone” or “picture stone.”
3.8    6.7	High point in highway is the divide between Kanab Creek and Johnson Wash drainages.
1.3    8.0	Water tower on left.

- 1.1 9.1 Johnson Canyon community business district on right.
- 0.8 9.9 Junction. Road to left proceeds up Johnson Canyon (see Johnson Canyon to Cannonville Road Guide). **Continue east on U.S. 89.** The Chocolate Cliffs continue to the south, as do the Vermilion Cliffs to the north.
- 0.7 10.6 Cross Johnson Wash and Hells Bellows. The butte to the left is Crescent Butte, exposing the Dinosaur Canyon Member (slope), topped by the Springdale Sandstone Member of the Moenave Formation. After passing the butte, the projection in the Vermilion Cliffs extending farthest south is Flag Point. Locally, the purplish Chinle Formation crops out at the base of the cliffs. At this place a thin veneer of Kayenta Formation makes up the top of the cliffs.
- 5.5 16.1 Junction. Dirt road to the left extends up Seaman Wash in the Petrified Forest Member of the Chinle Formation to Petrified Hollow (about 6.5 miles). The contact between the Shinarump Member and Petrified Forest Member is well exposed. Collecting petrified wood or other geologic materials is prohibited in the national monument. If you visit this place take the wood home on film. **Do not attempt to drive this road during wet weather** unless you wish to petrify yourself.
- 0.4 16.5 Cross Paunsaugunt fault. East of the fault, the Vermilion Cliffs are shifted northward about three miles and the Chocolate Cliffs are shifted from the south side of the highway to the north side. However, the Chocolate Cliffs are not well developed. The displacement along the Paunsaugunt normal fault is about 500 feet. The down-faulted block is to the west and thus displays inverse topography. The highway continues on Lower Triassic Moenkopi Formation and in assorted unconsolidated Quaternary units.
- 2.3 18.8 The road is now built upon the middle red member of the Moenkopi Formation. The ridge to the south (right) is part of the Kaibab uplift, a part of the same uplift into which the Grand Canyon has been carved.
- 1.6 20.4 The lighter beds in the Moenkopi Formation are gypsiferous. These gypsiferous beds are interbedded with light-brown siltstone and sandstone and make up the Shnabkaib Member. The middle red member, below the Shnabkaib, is exposed to the right of the highway where not covered by unconsolidated Quaternary units.
- 2.4 22.8 The Vermilion Cliffs can be seen in the distance to the left; locally, the White Cliffs (upper part of the Navajo Sandstone) appear above them.
- 2.4 25.2 The hills to the left near the road are lower red member capped with ledgy Virgin Limestone Member. The Virgin Limestone Member is a very thin unit of calcareous sandstone between the lower and upper red members at this location. To the right the low hills are upper red member. The road continues down Telegraph Flat.



- 2.7 27.9 Cross Kitchen Corral Wash. To the south a canyon opens known as Buckskin Gulch. This gulch becomes very deep 3 to 4 miles to the south and cuts into the Permian section, down to the Hermit Shale. A non-strenuous 7.5-mile hike down this canyon will be pleasurable and ends at a road in House Rock Valley. You will successively be able to examine the Timpoweap Member of the Moenkopi Formation, the Harrisburg and Fossil Mountain Members of the Permian Kaibab Limestone, the Woods Ranch and Brady Canyon Members of the Toroweap Formation, the Coconino Sandstone, and the Hermit Shale. These are the oldest rocks exposed in Grand Staircase-Escalante National Monument.
- 0.2 28.1 Junction to the left (see Kitchen Corral Wash road guide). The road north provides access to the White Cliffs and other viewpoints. The road is normally well maintained until it leaves the valley and canyon of Kitchen Corral Wash. Thereafter, the road becomes sandy and four-wheel-drive, high-clearance vehicles are necessary. The hike to Mollies Nipple along Pilot Ridge to Starlight Arch provides magnificent vistas, but is somewhat strenuous and time consuming (plan for the full day). After passing the junction, U.S. 89 goes through a road cut in terrace gravels. These gravels parallel Kitchen Corral Wash for several miles to the north and contain rounded quartzite cobbles derived from conglomerate at the base of the Pink Cliffs.
- 1.5 29.6 Junction to the right. The road south provides access to the Kaibab uplift area of the monument north of Kaibab Gulch. To the left, the Vermilion Cliffs expose the colorful variegated Petrified Forest Member of the Chinle Formation at the base, the Moenave Formation in the middle, and the Kayenta Formation (brown) at the top. The light-hued Navajo forms sandstone projections above.
- 3.6 33.2 The pointed, light-hued prominence above the Vermilion Cliffs to the left with dark rubble on the top is Mollies Nipple. The point is 7,270 feet above sea level. The highway is about 5,250 feet above sea level.
- 1.2 34.4 Paria Junction. **Turn left onto a side road** leading to the ghost town of Paria and the old Paria movie set. Take time to read the plaque on the rippled monolith of Moenkopi Formation. The road is well maintained, but is not recommended during wet weather. The road commences on alluvium.
- 1.2 35.6 The road crosses lower red member of the Moenkopi Formation. The yellowish sandy limestone beds near road level are Timpoweap Member of the Moenkopi Formation. The Timpoweap is a correlative of the Sinbad Limestone Member of the Moenkopi Formation in the San Rafael Swell in central Utah. The Timpoweap-Sinbad contains the Meekoceras (cephalopod) fossil zone. However, the outcrops here are mostly devoid of fossils.
- 0.1 35.7 Note the irregularly bleached lower red member to the left.

- 0.4 36.1 Cuesta on right is lower red member capped by very thin Virgin Limestone Member of the Moenkopi Formation. The Virgin is more resistant than the lower red and forms the cuesta cap.
- 0.9 37.0 At the bend in road, the Vermilion Cliffs, now participating in the East Kaibab monocline, are to the right. At the base is the Petrified Forest Member of the Chinle. The ledgy orange slope above it is the Dinosaur Canyon Member of the Moenave Formation. The cliff above the ledgy slope is the Springdale Sandstone Member of the Moenave Formation, and the highest ledges are Kayenta Formation.
- 0.3 37.3 The light beds are gypsiferous beds in the Shnabkaib Member of the Moenkopi Formation.
- 0.8 38.1 Look right. At the top of the escarpment is a thin scab of the Kayenta Formation. The brown cliff is the Springdale Sandstone Member of the Moenave Formation. The orange or light-brown slope below it is the Dinosaur Canyon Member of the Moenave Formation. Below this are the brightly banded or variegated slopes of the Petrified Forest Member of the Chinle Formation. Below are beds of the upper red member and the Shnabkaib Member of the Moenkopi Formation. The light-brown and white interbedded units beneath us are the Shnabkaib Member.
- 0.4 38.5 **STOP 1.** Gingham Skirts Butte. At this location the white discontinuous Shinarump appears between the brightly banded Petrified Forest Member of the Chinle Formation and the upper red member of the Moenkopi Formation. To the north, along the Paria River, deformation can be noted in the brightly banded Petrified Forest Member. Faults that parallel the Paria River Valley are all down-dropped valleyward (see Doelling and Davis, 1989). **After stop, proceed downward toward the valley**, first on the upper red member of the Moenkopi Formation, then on the Shinarump Member of the Chinle Formation.
- 0.6 39.1 **STOP 2.** Paria Movie Set. Enter movie set town on Main Street where the movie, "Outlaw Josie Wales" with Clint Eastwood was filmed many years ago. The Paria Movie Set was recently disassembled and removed after buildings were damaged in a flash flood. The BLM has reconstructed two buildings. Take time to explore this area by foot.

Walk 0.2 mile south (down drainage) from the picnic area to view a well-displayed Shinarump channel that cuts into the upper red member of the Moenkopi Formation. Take time to look at the thin beds of the Moenkopi Formation. Can you identify mudcracks from the vertical side? Some small faults are present, as well as foreset beds. Look north into the Shinarump Member. A small peek-a-boo arch is present. The gray steep slope above the Shinarump cliff is the Monitor Butte Member of the Chinle Formation. **Return to your vehicle at the movie set on Main Street and continue to cemetery.**

- 0.2 39.3 The Monitor Butte Member of the Chinle Formation is exposed immediately to the right of the road. The high prominence to the left is Calico Peak.
- 0.2 39.5 Paria (Pahrea) Cemetery is to the right with a plaque.
- 0.1 39.6 Rejoin cemetery bypass road and **continue left**.
- 0.1 39.7 Road is now on the Petrified Forest Member of the Chinle Formation. Note the popcorn-weathering texture in the bentonitic beds.
- 0.2 39.9 Road turns onto Paria River alluvium, **proceed to river bank**.
- 0.3 40.2 **STOP 3.** Paria River. This river drains an enormous area to the north and flows southward, reaching the Colorado River near Lees Ferry. Do not attempt to cross the river, even in your four-wheel-drive vehicle. Horrendous floods cause the river to spread across the entire valley. The old pioneer town of Paria (Pahrea) lay on the opposite side of the river. The pioneers hoped to establish a farming community in the valley, but time and time again floods washed their crops and homes away. A look at the width of the floodplain gives us visual evidence. A few remnants of buildings and other paraphernalia remain, some from an old gold-mining venture. From 1910 to 1913, the lower half of the Petrified Forest Member of the Chinle Formation was discovered to contain a small amount of gold. Lawson (1913) humorously stated that all the gold in the Chinle clay might be worth more than a trillion dollars if the clay from Kanab to Paria were all mined (Doelling and Davis, 1989). **After stop return to U.S. Highway 89.**
- 6.3 46.5 Junction, U.S. 89, **turn left**.
- 0.5 47.0 Low road cuts are in the Timpoweap Member of the Moenkopi Formation.
- 0.6 47.6 The thin ledge at the top of the lower red member of the Moenkopi Formation, exposed to the left, is all that remains of the Virgin Limestone Member at this location.
- 1.0 48.6 See the whaleback surface developed on the Kaibab uplift at 1 to 2 o'clock ahead. The surface of the whaleback is mainly the Timpoweap Member of the Moenkopi Formation. Steep canyons cut into the Harrisburg Member of the Permian Kaibab Limestone. The highway proceeds down Fivemile Valley.
- 2.5 51.1 Slow down and look into steep side canyons in the whaleback. Just before the highway turns left to cross the Cockscomb, the whaleback has a scab of the lower red member of the Moenkopi Formation on it. Underlying the lower red member is light-brown ledgy and sandy limestone beds of the Timpoweap Member, which is underlain by the white or very light gray limestones of the Harrisburg Member of the Kaibab Limestone. To the left in the Cockscomb (steepest part of the East Kaibab monocline) are numerous cuts made during

uranium times. These were the Radiance uranium mines. Here radioactive minerals coat fractures in the Moenave Formation sandstones. First developed during the radium "boom" just prior to World War I, work was revived during the mid-1950s. Only 173 pounds of  $U_3O_8$  were produced from the Radiance claims through 1973. Principal minerals included autunite, metatorbernite, and torbernite (Doelling and Davis, 1989).

- 0.4 51.5 Junction, right with House Rock Valley Road, which continues south into Arizona paralleling the Cockscomb. **Stay on U.S. Highway 89**, which turns sharply east and passes through steeply dipping and partly attenuated rocks. Notice how the brittle sandstone beds of the Moenave and Kayenta Formation fracture. We pass through Moenave and Kayenta quickly in the first cut. Can you separate them?
- 0.6 52.1 In the Navajo Sandstone, still dipping steeply to east.
- 0.4 52.5 Reddish band of the Judd Hollow Tongue of the Carmel Formation is exposed in the road cut. It contains some thin gray-pink muddy limestone beds, which are overlain by the Thousand Pockets Tongue of the Page Sandstone.
- 0.2 52.7 **STOP 4.** West Cove. Near where the highway emerges out of the cut, find a safe place to park; this can be a dangerous area because of the speed of the passing vehicles. To left and right, observe the dipping Carmel Formation on the flank of the Thousand Pockets Tongue (white sandstone). A white to yellow thick sandstone in the middle of the reddish Carmel Formation is the equivalent of the top of the Paria River Member of the Carmel. Rocks on the far side or east side of this thick sandstone are assigned to the Winsor Member. The Carmel Formation at this location is a terrestrial unit and contains no limestone or marine beds. Many of the sandstone beds contain biotite, suggesting they contain tuffaceous (volcanic ash) material probably from volcanoes far to the south in Arizona. Ahead at 11 o'clock is a white cliff with a single thick red band running through it. This is the Entrada Sandstone. Above the Entrada is the gray to gray-brown drab rocks of the coal-bearing Dakota Formation. A regional unconformity lies between the Dakota and Entrada separating Upper Cretaceous rocks from Middle Jurassic rocks. Locally, thin remnants of Lower Cretaceous rocks lie along the plane of the unconformity. After passing through the Cockscomb we are in the Kaiparowits basin. We have crossed from the Grand Staircase section into the Kaiparowits section of the monument.
- 0.3 53.0 Old highway continues north into West Cove area to left immediately after the end of the guard rail. The old highway is closed to vehicles. Hike into the West Cove area to view the Carmel Formation outcrops. These beds are beautifully exposed, showing many interesting bedding features. The highway continues in the Winsor Member of the Carmel Formation.
- 2.1 55.1 Johnson Store Butte to the right (Winsor Member of Carmel Formation). Note that the old ghost town of Adairville is being revived.

- 1.0 56.1 Cross Paria River.
- 0.3 56.4 Junction to Paria Primitive Area office on the right. Get permits to hike Paria River Primitive Area canyons (Paria River Canyon south of this location to Lees Ferry and the Dive, which starts in House Rock Valley). On the highway the Rim Rocks are to the left consisting of the brown- and white-banded Carmel at the base, the whitish Entrada Sandstone in the middle, and the gray Dakota Formation on top.
- 1.9 58.3 Enter East Cove. Highway rises through the Entrada into unconsolidated Quaternary mixed eolian and alluvial deposits (Qea).
- 1.3 59.6 Cottonwood Wash Road junction left (See Cottonwood Wash Geologic Road Guide). **Continue east** on U.S. Highway 89 and cross East Clark Bench, which is covered by Qea deposits. To the left, observe cliffs of the Straight Cliffs Formation at the south end of the Kaiparowits Plateau.
- 3.0 62.6 Cross Cedar Hollow, a gulch that cuts into the Carmel Formation.
- 1.1 63.7 Community of Church Wells, left.
- 1.4 65.1 To the left in the middle distance is a mound of white sandstone of the Entrada. This mound marks the axis of the poorly defined Long Flat-Cedar Mountain anticline, which continues under the Qea deposits to the south. To right, reddish beds of Judd Hollow Tongue of Carmel Formation are interbedded with light ledges of Page Sandstone; all overlying the light-hued and cross-bedded Navajo Sandstone.
- 2.9 68.0 Knoll to right exposes Navajo Sandstone at base (light sandstone) with reddish Carmel and Page on top. The highway begins its descent into the Wahweap syncline.
- 0.9 68.9 Look right and see the Echo monocline, which develops between the Cedar Mountain anticline and the Wahweap syncline to the south. Big Water community lies ahead.
- 1.2 70.1 Big Water junction left. **U.S. 89 continues eastward** into Arizona (8 miles to the border) to Glen Canyon Dam and Lake Powell to Page, Arizona (19 miles).

## END OF ROAD GUIDE

## JOHNSON CANYON-CANNONVILLE

This geologic road guide commences on a paved road that traverses through Johnson Canyon, continues on Skutumpah Road, which is graveled but becomes a rough dirt road before arriving in Cannonville. This Skutumpah Road is generally passable in a passenger vehicle, but a high-clearance vehicle is recommended. **The latter part of the route is not recommended during wet weather.** Many drainages cross this road, blocking access when in flood.

The road guide commences at the junction of the Johnson Canyon Road and U.S. Highway 89 about 10 miles east of Kanab (Mile 9.9 on Kanab to Big Water guide). The paved road extends northward. This road guide covers 51 miles and will take at least two hours of driving time. Photography and stops will result in additional time.

MILEAGE INTERVAL/CUMULATIVE		DESCRIPTION
0.0	0.0	Proceed up the valley of Johnson Wash. The Vermilion Cliffs are exposed to the left and right, the strata dipping gently northward. At the base is the Petrified Forest Member of the Chinle Formation (blue clay). Above the Chinle is an orange-brown slope of the Dinosaur Canyon Member of the Lower Jurassic Moenave Formation, overlain by an orange-brown Springdale Sandstone Member cliff. The ledgy slope above the Springdale Sandstone is the Kayenta Formation. The light-colored sandstone seen locally at the very top is the Lamb Point Tongue of the Navajo Sandstone.
1.4	1.4	The road passes orangish smooth-weathering Moenave Formation rocks in a road cut.
1.4	2.8	The ledgy slope to the left is the main body of the Kayenta Formation. The light-hued sandstone beds that overlie it are the Lamb Point Tongue of the Navajo Sandstone.
0.7	3.5	Cross bridge, the road turns right. Note Lamb Point Tongue sandstone beds stained red on the right.
1.0	4.5	Red thin-bedded rocks on top of the Lamb Point Tongue are Tenney Canyon Tongue of the Kayenta Formation. The Tenney Canyon Tongue pinches out eastward into the Navajo Sandstone.
1.0	5.5	The movie set ahead and to the right was used for Gunsmoke TV show series.
0.5	6.0	Note faults to the left (displaced strata). This zone of faults is considered active (Doelling and Davis, 1989). The faults (Johnson Canyon fault zone) parallel the valley and are mostly on the west side. Notice the nice cross-bedding in the Lamb Point Tongue.
1.2	7.2	More displaced strata to the left. The White Cliffs may be seen ahead.

- 0.9 8.1 Note the Tenney Canyon Tongue, now on the right side of the highway above the cross-bedded Navajo. Notice that most of the displacement in this part of the Johnson Canyon fault zone is down to the west.
- 1.5 9.6 We are in low rolling hills of pink Navajo Sandstone. We are rising stratigraphically. This stratigraphic interval can be divided into the following units in this part of the monument (in ascending order): Lamb Point Tongue of Navajo Sandstone, Tenney Canyon Tongue of Kayenta Formation, brown Navajo Sandstone, pink Navajo Sandstone, and white Navajo Sandstone. The brown and white units form cliffs; the white Navajo is responsible for the White Cliffs, which is an important step or riser in the Grand Staircase. The pink Navajo is softer and forms benches and hills. Here we are on the Wygaret Terrace.
- 0.5 10.1 Cross Johnson Wash, followed by cattle guard.
- 1.1 11.2 Pass Grand Staircase-Escalante National Monument sign on the right.
- 0.9 12.1 The white Navajo Sandstone is now down to road level as we enter a canyon. Notice the thick sandy alluvium of Johnson Wash.
- 1.8 13.9 **STOP 1.** White Cliffs and olivine basalt flow. At this point Skutumpah Canyon comes in from the right and the road continues up Johnson Wash Canyon. Look for the short side road to see the lower end of a basalt flow. The Co-op Creek Limestone Member of the Carmel Formation is at the top of the White Cliffs, the top of which forms the Skutumpah Terrace. The lower lava is disconnected from the main lava flow, which is on the Skutumpah Terrace. The source of the lava is a volcano located seven miles to the north known as Bald Knoll. The lava rock (olivine basalt) is generally gray to black, dense, and vesicular. Under the microscope the rock shows sparse olivine phenocrysts, titaniferous augite, labradorite, and very small phenocrysts of iron-titanium oxides in a groundmass of the same minerals. **After stop, continue up Johnson Canyon** and enjoy the beautiful cross-beds and checkerboard patterns in the white Navajo Sandstone.
- 1.7 15.6 Co-op Creek Limestone Member rocks are now at road level. These are yellow gray and thin bedded.
- 0.4 16.0 Junction, **turn right and continue eastward on gravel or dirt road.** Immediately after the turn, look left (north)—more lava rock can be seen in the middle distance.
- 0.2 16.2 Road cut is in medium-bedded limestone beds of the Co-op Creek Member of the Carmel Formation.
- 1.0 17.2 Road now extends on wind-blown silty soils on the Skutumpah Terrace.

- 0.4 17.6 **Stay on main road.** Roads left and right extend to private holdings. Drop into Skutumpah Creek drainage.
- 0.6 18.2 Cross Skutumpah Creek and continue to drive the main road. Skutumpah Ranch buildings are to the south. To the left are views of the Pink and Gray Cliffs.
- 0.6 18.8 Junction, **keep right on main road.** Road to left proceeds to Deer Spring Ranch.
- 0.2 19.0 White mounds to the left are gypsum in the Paria River Member of the Carmel Formation. We proceed up Red Wash drainage for the next mile or two.
- 1.3 20.3 We are now in upper part of the Red Wash drainage in the Co-op Creek Member of the Carmel Formation.
- 0.5 20.8 To the left are the Gray Cliffs and Carley Knoll (pointed peak). Here the Gray Cliffs are of the Dakota Formation that overlies yellow- and red-banded Carmel Formation beds. Note that the Middle Jurassic Entrada Sandstone, Upper Jurassic Morrison Formation, and the Lower Cretaceous Cedar Mountain Formation are cut out by the sub-Dakota unconformity in this area.
- 0.9 21.7 Road to Skutumpah Pasture is on right. **Stay on main road.** The road is now on a mix of alluvium and loess.
- 1.9 23.6 Road drops into Adams Wash drainage.
- 0.9 24.5 Cross the wash and note the gravel pit right. The road is on alluvium between the Carmel Formation hills.
- 0.8 25.3 To the left, the Dakota Formation (gray) rests on Winsor Member of Carmel Formation (brightly banded). The road rises again.
- 0.6 25.9 Light- to medium-banded rocks in road cut are Crystal Creek Member of the Carmel Formation.
- 0.5 26.4 Cross Dunham Wash. Nice view of the White Cliffs ahead, here elevated by a fault.
- 0.6 27.0 Junction. **Keep left on main road** up through the cut in the Carmel Formation. Road to the right gives access to Deer Springs Ranch buildings and a private road along Deer Springs Wash. After passing through the Carmel road cut, the road rises onto a pediment gravel surface containing quartzite, sandstone, and siliceous limestone cobbles eroded from the basal Claron Formation, and sandstone from Upper Cretaceous formations.



- 0.3 27.3 **Stay on county road.** Adjoining roads lead to private holdings. Nice view of the Gray Cliffs to the left with more orangish pediment gravels on top. The Winsor Member of the Carmel Formation makes up the base.
- 0.6 27.9 Road cut in pediment gravels.
- 0.1 28.0 Cross Meadow Creek. Pink Cliffs in the distance to the left.
- 0.8 28.8 Road proceeds up Dry Valley.
- 1.1 29.9 Drop into Lick Wash.
- 0.4 30.3 **STOP 2.** Lick Wash. After crossing Lick Wash, a trail (infrequently used road) extends to the right (south). Pull off the main road, get out of the vehicle, and walk about. To the south, the white or light-gray outcrops of the white Navajo Sandstone are visible. These are bounded by a northeast-trending fault with the downthrown block to the northwest. Lick Wash Canyon is fun to hike south of the road. After entering the canyon, excellent examples of cross-bedding in the Navajo Sandstone is preserved. The hill to the east shows yellow-gray, thin-bedded Co-op Creek limestone covered by red- and white-banded Crystal Creek Member of the Carmel Formation. The Crystal Creek Member is overlain by the Thousand Pockets Tongue of the Page Sandstone. This is the westernmost exposure of the tongue. Gypsum of the Paria River Member immediately overlies the tongue wherever it is present (the gypsum is discontinuous). The Paria River Member is overlain by yellowish and reddish Winsor Member. Looking to the north from this location are the Gray Cliffs consisting of Dakota Formation rocks. Some pinkish coloration is present due to the natural burning or oxidation of its thin coalbeds. Under the gray is a hardened yellow rock that is difficult to separate from the yellow and red sandstone beds of the Winsor Member of the Carmel. This hardened yellow rock is a remnant of the Entrada Sandstone. The unconformity at the base of the Dakota Formation cuts out the Entrada west of this location so that the Dakota rests on the Winsor Member of the Carmel Formation. From here eastward to the end of this road guide, the Dakota rests on the Entrada Sandstone. **After stop continue eastward back on the main road.**
- 1.0 31.3 Outcrops of the Thousand Pockets Tongue rest on the Crystal Creek Member of the Carmel Formation to the right. Gypsum of the Paria River Member overlies the yellow Thousand Pockets. Gray Cliffs continue on the left.
- 1.2 32.5 Views of the Pink Cliffs in the distance to the left for the next few miles.
- 1.8 34.3 Cross Bullrush Hollow. Nice view of the Pink Cliffs to the left.
- 1.0 35.3 More gypsum of the Paria River Member exposed to the left.

- 1.2 36.5 **STOP 3.** Paria Amphitheater Overlook at turn in road. In the middle ground to the north is the Winsor Member of the Carmel Formation (white and pink sandy siltstone), which overlies a layer of gypsum in the Paria River Member of the Carmel Formation, which in turn overlies a very yellow Thousand Pockets Tongue of the Page Sandstone. The Thousand Pockets overlies red beds of the Crystal Creek Member of the Carmel Formation, which overlies the Co-op Creek Limestone Member of the Carmel Formation in Indian Hollow. You should be able to pick out all these members at this viewpoint. The Pink Cliffs exposed in the far distance across the amphitheater to the northeast is the Table Cliff Plateau. The high hill or mountain south of Table Cliff Plateau is Canaan Peak in the northern Kaiparowits Plateau. The flat benches ahead of us are capped with pediment gravels and Qea resting on various Carmel Formation Members. **After "look-see" continue driving down Indian Hollow drainage,** which starts in the Winsor Member of the Carmel Formation and stratigraphically descends all the way to the Co-op Creek Limestone Member of the Carmel Formation.
- 1.0 37.5 Cross wash in Co-op Creek Limestone Member, which is a yellow-gray, thin-bedded, platy-weathering limestone. The road will be in this member for the next mile or two.
- 0.9 38.4 Cross wash. The yellow Thousand Pockets Tongue is visible ahead overlying the reddish or brownish Crystal Creek Member. The contacts are clearly visible between these thin units.
- 0.9 39.3 The road joins Bull Run drainage, affording more views of the Carmel Formation members. Road continues in the Co-op Creek Limestone Member for about a mile.
- 0.6 39.9 Note the thin gypsum bed in the Co-op Creek Limestone Member in the cut to the left.
- 0.5 40.4 **STOP 4.** Bull Valley Gorge. This is a slot canyon cut into the Navajo Sandstone. Hikes start here going upstream and downstream. Take your camera. Park another 0.1 mile up the road. By now you should be able to identify the Crystal Creek and Thousand Pockets Tongue above. **After the stop, continue on the main road** in the Co-op Creek Limestone Member.
- 0.3 40.7 Road rises onto loess-covered bench. The loess is not thick and locally white gypsum of the Paria River Member makes up the surface of the road.
- 1.4 42.1 Drop into Willis Creek drainage through the Thousand Pockets, Crystal Creek and Co-op Creek Members. Look right and you will notice that Willis Creek cuts into the Navajo Sandstone as well.
- 0.4 42.5 Cross Willis Creek.

- 0.4 42.9 Road turns out of Willis Creek drainage through the Thousand Pockets Tongue and Paria River and Winsor Members of the Carmel Formation onto a pediment gravel covered by loess.
- 0.7 43.6 Views of the Pink Cliffs of Bryce Canyon National Park to left.
- 0.2 43.8 Road drops into Averett Canyon. Pass through thick gypsum of the Paria Member of the Carmel Formation and yellow sandstone of the underlying Thousand Pockets Tongue of the Page Sandstone.
- 0.2 44.0 Cross wash in the Crystal Creek Member.
- 0.2 44.2 Rise out of the wash to **STOP 5**. Gypsum of the Paria River Member. Walk on gypsum to canyon edge. Note that there is no gypsum bed on the Thousand Pockets Tongue on the far side of the canyon. Gypsum is an evaporite that does not dissolve quickly and hence is a cliff-former in this dry climate. Note the crusty surface on the gypsum. Commonly, a crust of cryptobiotic soil develops on gypsum. Gypsum deposits are favored by this symbiotic community. Most parks encourage visitors not to walk on the crust.
- 0.8 45.0 Drop into Sheep Creek drainage, still in Carmel Formation members.
- 0.5 45.5 Thousand Pockets Tongue above drainage on right.
- 0.2 45.7 Cross Sheep Creek drainage at spillway and dam. This was a flood control dam built by the Bureau of Reclamation. It silted up within five years of its construction.
- 1.9 47.6 Descend to the Paria River Valley. The road proceeds down a hill of the Winsor Member of the Carmel Formation (light-brown).
- 1.0 48.6 Cross Yellow Creek.
- 0.1 48.7 Junction. This is the end of the Skutumpah Road. **Join pavement and turn left toward Cannonville** (see Cottonwood Wash Geologic Road Guide if you choose to turn right).
- 0.3 49.0 Junction. **Stay on pavement to Cannonville**. Enter Garfield County.
- 0.6 49.6 View of orange-brown slickrock to right. This slickrock is Gunsight Butte Member of the Entrada Sandstone.
- 0.4 50.0 To left are orange-brown Gunsight Butte outcrops overlain by lightly banded Cannonville Member outcrops.
- 0.4 50.4 Enter town of Cannonville.

0.4 50.8 **STOP 6.** Cannonville Park. Look west. Lower part of cliff is lightly banded Cannonville Member of the Entrada Sandstone, overlain by grayish Dakota Formation. This is the type section for the Cannonville Member. The red at the base is the top of the Gunsight Butte Member of the Entrada Sandstone.

**END OF ROAD GUIDE.** Continue north to junction with Utah State Highway 12 for access to Bryce Canyon National Park (left) or follow the Cannonville to Boulder Geologic Road Guide (right).

## COTTONWOOD WASH

This geologic road guide route commences on a paved road, but most is along a very rough dirt road before arriving at U.S. Highway 89. This road is generally passable in a passenger vehicle, but a high-clearance vehicle is recommended. **Continuing past Kodachrome State Park is not recommended during wet weather.** Many drainages cross this road, blocking access during floods.

The road guide commences at the junction of the Kodachrome State Park highway and Utah State Highway 12 at Cannonville at the northern part of the route. The Kodachrome State Park road becomes the Cottonwood Wash Road where the pavement ends. The guide covers about 49 miles and the driving should take about 2.5 hours, not counting time for stops and photography.

MILEAGE INTERVAL/CUMULATIVE	DESCRIPTION
0.0    0.0	Junction, Kodachrome State Park Road and Utah State Highway 12 at Cannonville. <b>Proceed south</b> on the Kodachrome State Park Road.
0.1    0.1	Cannonville City Park on right. This is the end of the Johnson Canyon-Cannonville Geologic Road Guide.
0.4    0.5	Entrada Sandstone outcrops on the right, overlain by the Dakota Formation. The lightly banded part of the Entrada is the Cannonville Member; the orange-red unit underneath is the Gunsight Butte Member.
2.1    2.6	Junction with Yellow Creek Road. <b>Continue on pavement.</b> The Yellow Creek Road provides access to the base of the Pink Cliffs below Bryce Canyon National Park. Enter Kane County. To the left, the Winsor Member of the Carmel Formation (brown) is overlain by the Gunsight Butte Member of the Entrada. The beds dip north.
0.3    2.9	Junction with Skutumpah Road. <b>Stay on the pavement.</b> The geology along Skutumpah Road is described in the Johnson Canyon-Cannonville Geologic Road Guide.
0.4    3.3	Cross Paria River.
1.1    4.4	The chippy white limestone marks the top of the Paria River Member of the Carmel Formation. Trace it down the river valley.
0.5    4.9	In the wall at 10 to 11 o'clock are numerous small structures, including a syncline, faults, and collapse features. These are in the Winsor Member of the Carmel Formation, which is unconformably overlain by a semiconsolidated gravel deposit.
0.2    5.1	<b>The road makes a turn around Shepherd Point.</b> Road cut is in the Winsor Member of the Carmel Formation.

- 0.2    5.3    **STOP 1.** Collapse feature in Winsor Member. Look back just north of Shepherd Point. Several hundred pipes and collapse features such as this one are present in the San Rafael Group in this area. The San Rafael Group includes all the Middle Jurassic formations in this area; (in ascending order) Page Sandstone, Carmel Formation, and Entrada Sandstone. Some pipes are large, some pipes are tiny. The best can be seen in Kodachrome Basin State Park (Baer and Steed, 2000). Hornbacher (1984) counted more than 50 of them in the state park. Some, in the Thousand Pockets Tongue of the Page Sandstone, are mineralized with small amounts of copper, lead, and silver. The origin of these pipes are debatable (see Chidsey and others, this compact disc). Several small faults are observable under the gravel cap at this location as well. The road continues in the Winsor Member.
- 1.0    6.3    The regional dip is northward. The light rocks dipping toward the road from the south are the chippy limestones at the top of the Paria River Member.
- 1.0    7.3    Kodachrome State Park junction. The pavement turns sharply to the left to provide access into the state park. **We continue straight on the dirt road.** To the left are Winsor outcrops overlain by the Entrada Gunsight Butte Member. The Winsor begins to contain thin gypsum beds.
- 0.8    8.1    Junction, **stay on the main road.** Do not go right. Many tributary roads go left and right in the next several miles. All of these are dead-end roads. **Stay on the main road.**
- 0.9    9.0    Cross Rock Springs Creek or wash, which can carry immense flash floods. Do not cross in case of a flood. It has cut a deep ravine in alluvium. The different color bands in the alluvium represent detritus from different source areas upstream.
- 1.6    10.6    Bluffs to left expose gypsiferous Winsor beds overlain by Gunsight Butte Entrada. Look for criss-crossing gypsum veinlets in the Winsor above road level. Road soon reaches cuts in the light-gray to white chippy limestone beds at the top of the Paria River Member. Gypsum of the Paria River Member can locally be seen in the drainage to the right.
- 1.6    12.2    To left and right, typical orange-brown slick rock of the Gunsight Butte Member is observable.
- 0.6    12.8    Start ascent to Slick Rock Bench.
- 0.3    13.1    **STOP 2.** Wiggler Wash Overlook. The view north shows steeply dipping rocks in a monocline between a branch of the Kaibab anticline and the Hackberry Canyon syncline. Wiggler Wash has cut a gap in Entrada Sandstone Members capped by the hard Henrieville Sandstone of Thompson and Stokes (1970). In the background behind the gap, one can see the Tropic Shale overlain by the

ledgy and cliffy Straight Cliffs Formation. A little to the right of the gap on the horizon is Canaan Peak. A little to the left of the gap on the horizon is the Table Cliff Plateau. The stop is on Slick Rock Bench, a pediment-mantle deposit composed of rounded cobbles of quartzite and sandstone derived from the base of the Pink Cliffs. Conglomeratic units at the base of the Pink Cliffs are the source of the cobbles. These conglomeratic units are exposed on Canaan Peak. **After the stop, continue on the main road.** After crossing the bench we drop through the gravel into Round Valley Draw.

- 0.9 14.0 Round Valley Draw. Road now parallels a cliff on the left with lightly banded Cannonville Member at the base and the overlying Henrieville Sandstone forming the cliff. The steep gray slope above the cliff is the coal-bearing Dakota Formation. The coal seams are thin here.
- 0.1 14.1 Junction on right with road giving access to the Rush Beds. **Stay on the main road.** The Rush Bed Road is a dead-end road crossing sand dunes. It is strictly a four-wheel-drive road; and even with a four-wheel-drive vehicle, we may never see you again.
- 0.9 15.0 Enter Butler Valley.
- 2.0 17.0 Junction, **turn left to Grosvenor Arch.** Road is in Winsor Member of Carmel.
- 0.9 17.9 **STOP 3.** Grosvenor Arch. Take a short hike to the base of Grosvenor Arch. This is a double free-standing arch. The base is in Henrieville Sandstone. A slightly darker conglomeratic sandstone in the upper part of the arch unconformably overlies the Henrieville. Pollen in siltstone partings in this conglomeratic sandstone yield an Early Cretaceous age. The rock is equivalent in age with the Cedar Mountain Formation as found in the San Rafael Swell. Unconformably overlying the conglomeratic sandstone, but not participating in the arch, is the gray and dark-brown Upper Cretaceous Dakota Formation. At this place the rocks begin to dip sharply to the east into the East Kaibab monocline. Looking south one can see the Dakota resting on the Cedar Mountain Formation and lighter Henrieville Sandstone. On the skyline to the south is a very steeply dipping hogback of the Straight Cliffs Formation at the north end of the Cockscomb. **After stop, return to junction at mile 17.0.**
- 0.9 18.8 Junction, **turn left** (south).
- 0.7 19.5 Junction; road to left closed to vehicles.
- 2.0 21.5 Cross wash in Carmel Formation. Note the yellow sandstone cliff of the Thousand Pockets Tongue of the Page Sandstone to the right; below the cliffs are outcrops of the Crystal Creek and Co-op Creek Members of the Carmel Formation. These Carmel Formation units become very thin to the south in the steep fold of the East Kaibab monocline. They are henceforth joined and termed the Judd Hollow Member of the Carmel Formation. From this point southward,

Cottonwood Wash has cut a very narrow slot canyon through the Thousand Pockets Tongue and Navajo Sandstone. Hiking down this canyon can be a fun experience. Do not attempt it with thunderheads building to the north. There are stretches where there is no escape should a flood flow down the canyon. The hike would proceed down the drainage to the right.

- 0.9 22.4 **STOP 4.** The Squeeze. A short turn-around road turns off the Cottonwood Wash Road to the right. This is a good place to park the vehicle. Take a quarter-mile hike to the south on the ridge to the right of the road and look southward. The vertical white Thousand Pockets Tongue supports the ridge. To the south, look at the tightest place along the East Kaibab monocline. Rocks are squeezed, thrust, and thinned by attenuation. The softer layers of the Carmel Formation are those suffering the most attenuation across the monocline. This place is beautiful since the units are colorful. Basically the older rocks are exposed to the right (west), the younger to the left (east). **After the stop, return to your vehicle and drive through The Squeeze.**
- 0.3 22.7 At the low point in The Squeeze. To the right is a break in the Thousand Pockets wall where you can exit or enter the canyon of Cottonwood Wash. You can hike upstream back to mile 22.1 on the guide or down to meet the road about 1.5 miles downstream in the slot canyon. Remember the flash-flood warnings given at milepost 22.1.
- 0.1 22.8 Santa Claus rock. Look before you get to it on the left.
- 0.1 22.9 South end of The Squeeze. You may wish to look back to the north to see more structures associated with the folding. To the right (west) is the vertical wall of the Thousand Pockets Tongue. On the left (east) is the light-hued Entrada Sandstone capped by the Dakota Formation.
- 0.9 23.8 The road continues along the Tropic Shale and Dakota Formation.
- 0.3 24.1 On the right across Cottonwood Wash are deep red and white beds of the Paria River Member of the Carmel Formation. The white massive sandstone behind it is the Thousand Pockets Tongue. Red beds underneath the Thousand Pockets are Judd Hollow Tongue of the Carmel Formation. Beneath this is the Navajo Sandstone. This part of the Cockscomb is jostled with many small faults.
- 0.6 24.7 Cross a tributary wash coming in from the left. Look up the canyon to the left. The road is on the Dakota Formation; the unit to the left is the Tropic Shale overlain by the Straight Cliffs Formation. On the horizon is another cliff consisting of the Wahweap Formation. To the right, across Cottonwood Wash, is a tributary canyon draining areas to the west. It cuts through the Thousand Pockets Tongue, Judd Hollow Tongue, and Navajo Sandstone. The missing Entrada Sandstone and upper Carmel units are probably attenuated under the valley alluvium.



- 0.7 25.4 A rib of Entrada Sandstone shows up left of the road as irregularly resistant spires. The valley widens and white Cannonville Member crops out.
- 1.8 27.2 Pump Canyon Spring. White Entrada outcrops to the left and thick alluvium (up to 40 feet thick) to the right. Some of this thick alluvium may be lacustrine in origin, indicating a possible landslide dam during the Pleistocene.
- 0.5 27.7 An alcove in the Thousand Pockets Tongue on right.
- 0.6 28.3 Cretaceous rocks are on the left and the Thousand Pockets Tongue is on the right, separated by alluvium and/or lacustrine beds.
- 0.5 28.8 Road to right is a dead end to the trailhead leading to another spring.
- 0.2 29.0 High prominences in middle of valley are Entrada Sandstone. Note purple ash layer in the Entrada Sandstone (on far side of prominences).
- 0.6 29.6 Road is now on Tropic Shale between Dakota hogbacks on right and the Straight Cliffs Formation on left.
- 0.5 30.1 After the rise, the road continues in swale in the Tropic Shale. Note the hogbacks of the Dakota Formation on the right and the steeply dipping Straight Cliffs strata to the left. A thin coalbed crops out at the top of the Dakota Formation.
- 0.5 30.6 Road passes through gap in the Dakota. Watch for thin coal seams.
- 0.6 31.2 Valley widens again. On left is the Cannonville Member of the Entrada Sandstone with purple to red-brown volcanic ash-bearing bands. Above is the Dakota hogback. To the right are scabs of Carmel Formation (red) on Thousand Pockets Tongue and Navajo Sandstone.
- 0.9 32.1 To the left in the middle of the valley are prominences of the Gunsight Butte Member of the Entrada Sandstone.
- 1.9 34.0 The large canyon opening to the right is Hackberry Canyon. A worthwhile hike into the canyon begins as a slot canyon in the Navajo. Farther up, the canyon widens into a broad valley floored by the Petrified Forest Member of the Chinle. To the left, after passing the bold prominences of the Gunsight Butte Member, is the banded Cannonville Member of the Entrada Sandstone overlain by the Dakota Formation in a hogback. Note that the alluvium here is derived principally from the Tropic Shale.
- 0.6 34.6 More monuments of Gunsight Butte Member appear on the left.
- 0.7 35.3 Road turns left to go through another Dakota gap. A good view of the banded Cannonville Member shows up to the left.

- 0.4 35.7 Climb up the Tropic Shale. Take time to look back at the hogbacks and the Tropic Shale. Fence post-like pieces of Dakota sandstone litter the hogback dip slope. Look ahead at an old Pleistocene erosion surface that developed on and truncated the dipping Entrada and Dakota strata.
- 0.9 36.6 The road now angles gradually away from the Cockscomb or East Kaibab monocline. Cottonwood Wash flows into the Paria River just to the west. The Paria River cuts perpendicularly through the Cockscomb from the ghost town of Paria a few miles to the west. From this point the road accompanies the Paria River (right) for several miles.
- 0.6 37.2 Look right across the salt cedar (tamarisk) forest and under the 140 kilovolt (KV) power line at the Dakota hogback across the river. The Dakota hogback top is planed flat along an old terrace or pediment surface.
- 0.8 38.0 Note the old road heading to disaster in the Paria River. The river has steadily cut cliffward at this point. A flood took out the old road in the early 1980s.
- 0.1 38.1 On the rise, look ahead at the cliff to the left of the road. We are in the upper part of the Tropic Shale, here consisting of thin beds of offshore sandstone and mudstone. The first thick sandstone cliff-former above these thin beds is the base of the Straight Cliffs Formation. Keep left. Watch out for slump blocks to the left.
- 0.9 39.0 Road continues on a widened valley alluvium. Straight Cliffs Formation on Tropic Shale crops out on both sides of the valley.
- 0.4 39.4 Road gets pushed against the left cliff again. Keep left.
- 0.3 39.7 Road on alluvium again.
- 0.9 40.6 Road goes over a rise. Look right at an old erosional pediment surface extending eastward from the Cockscomb. The road gradually descends stratigraphically deeper into the Tropic Shale and into the darker parts of the formation. Note the large rock-fall blocks to the left at the base of the Tropic Shale slope.
- 1.3 41.9 “Moonscape” in the Tropic Shale to the left.
- 0.2 42.1 Road begins ascent on Dakota Formation dip slope. The brown strata of the Dakota can be seen rising southward across the Paria River on the right. The road now turns eastward away from the Paria River.
- 0.2 42.3 Note the rounded quartzite cobbles from a pediment-mantle deposit above. The road cut here is on a scab of Tropic Shale on the Dakota. The road continues on the Tropic and crosses the top of the Dakota Formation in gullies for the next few miles.

- 2.5 44.8 Road turns off the Tropic Shale and proceeds up the Dakota Formation dip slope, which is veneered with light-brown sandy soil.
- 2.0 46.8 Junction with East Rim Rocks Road. The East Rim Rocks Road continues on the bench on which you have traveled for the last two or three miles. Take time to look behind you at the south end of the Kaiparowits Plateau with the Straight Cliffs Formation above the Tropic Shale. The highest formation observable on the Kaiparowits Plateau from here is the Wahweap Formation. **Continue south on the main road** in the Dakota Formation.
- 0.5 47.3 Road breaks out on the Rim Rocks escarpment.
- 0.1 47.4 Contact between the Dakota and Entrada Formations; brown sandstone beds on light-brown or pink sandstone. Road drops in elevation to U.S. 89 on sandy weathered Entrada. Abundant rockfall on the Entrada Sandstone.
- 0.9 48.3 Junction with U.S. 89. Right to Kanab and left to Page. See Kanab to Big Water along U.S. Highway 89 Geologic Road Guide for geologic description along U.S. highway 89.

**END OF ROAD GUIDE**

## CANNONVILLE TO BOULDER ALONG UTAH STATE HIGHWAY 12

This geologic road guide follows Utah State Highway 12 from Cannonville to Boulder, and, except for a short side trip, is all on pavement for a distance of about 74 miles.

MILEAGE INTERVAL/CUMULATIVE	DESCRIPTION
0.0    0.0	Junction, Kodachrome State Park road (see connecting Cottonwood Wash and Johnson Canyon-Cannonville Geologic Road Guides) and Utah State Highway 12 at Cannonville. <b>Proceed east</b> on State Highway 12 and cross Paria River.
0.7    0.7	Deep road cut in Entrada Sandstone exposing the Gunsight Butte and overlying Cannonville Members. After passing through the cut, the same stratigraphy is brought to view in the bluffs to the left. The Henrieville Sandstone makes appearance on top of the Cannonville Member.
1.9    2.6	The Dakota Formation caps the Henrieville Sandstone to the left. The Dakota contains thin coalbeds.
0.5    3.1	Cross creek and enter Henrieville town, Utah.
0.5    3.6	Bend in highway, road turns left and north. Nice views of the Dakota overlying Entrada Sandstone to left and right.
1.0    4.6	Interesting erosional forms are in the Henrieville Sandstone to the right. Red coloration in the Dakota usually indicates that the thin coalbeds have been naturally burned (oxidized) along outcrop.
1.4    6.0	Highway bends eastward (right) and is on the Tropic Shale going up Dry Valley.
1.4    7.4	Straight Cliffs Formation lies above Tropic Shale to the left as you pass under the power line.
1.7    9.1	<b>STOP 1.</b> Straight Cliffs Formation. Pull off near the transformer power station to look at the Straight Cliffs Formation and its members. The lowest cliff is the Tibbet Canyon Member, above which is the Smoky Hollow Member. All the ledges between the Smoky Hollow and an upper thick ledge belong to the John Henry Member. The thick upper ledge is the Drip Tank Member. A thick coalbed in the Henderson coal zone is found a short distance above the Smoky Hollow Member. It contains about 7 feet of coal along the highway, but to the north and west it thickens to as much as 18 feet. Small mines operated in the Henderson coal in the early and middle 20th century and supplied coal to local markets. The mines are now closed.

- 0.7 9.8 Massive cliff face on right is the Drip Tank Member of the Straight Cliffs Formation. Above it are the sandstone and mudstone beds of the Wahweap Formation.
- 1.8 11.6 Cross Henrieville Creek. The impressive cliff face on the left is the upper Wahweap Formation. The road continues up a thick gravel deposit composed of quartzite cobbles derived from the Canaan Peak Formation.
- 1.8 13.4 **STOP 2.** Lower Blues viewpoint turnoff. A short turnaround is present to the left of the highway. Look south across The Blues. More than 2,000 feet of Kaiparowits Formation was deposited here and forms gray badlands. Above the Kaiparowits Formation is Table Cliff Plateau at Powell Point. The Pink Cliffs (pink part of the Claron Formation) are evident, with white Claron above. At the base of the Pink Cliffs is the Canaan Peak Formation, a conglomerate that is the source of the cobble deposit you are standing on. The Canaan Peak Formation is also present under the Claron to the south under Canaan Peak. This is an afternoon viewpoint. The Blues can also be viewed from the top of the highway grade at the next stop (STOP 2A), which is better in the morning. The road now proceeds up a canyon in the Kaiparowits Formation. The road goes up a steep grade.
- 2.3 15.7 **STOP 2A.** Upper Blues viewpoint **turnoff left or right.** Same comments as for lower Blues viewpoint. Look far to the west to see the Pink Cliffs of Bryce Canyon across the Paria Amphitheater. Powell Point is 10,188 feet above sea level. After the stop the road starts down Upper Valley, which is developed on the Kaiparowits Formation.
- 1.6 17.3 Boulder Mountain looms on the horizon ahead. Nice view of the Pink Cliffs below Table Cliff Plateau left. The rise to Canaan Peak commences unimpressively to the right.
- 2.1 19.4 Road commencing from the highway to the right provides access to Canaan Peak sites (Dixie National Forest).
- 1.0 20.4 Dirt road commencing from the highway to the right provides access to Pet Hollow (scenic drive).
- 0.8 21.2 Road cut in Pleistocene gravels.
- 0.7 21.9 Cross Water Canyon.
- 0.6 22.5 Steep flank of Upper Valley anticline to right. The road has crossed into the Straight Cliffs Formation. The anticlinal axis can be viewed ahead. The Straight Cliffs Formation is coal bearing here, but the beds are hidden between the sandstone ledges. A dirt road extending to the left provides access to the base of the Pink Cliffs in the Dixie National Forest.

- 1.0 23.5 Cross axis of Upper Valley anticline, which produces oil from Permian Kaibab Limestone along its southwest flank to the southeast. Upper Valley Wash to the right cuts into thick alluvium. Cliffs of Straight Cliffs Formation are to the left. Ledges begin to dip eastward on the anticline's gentle flank. The road descends almost as much as the dip of the beds.
- 2.8 26.3 **STOP 3.** Scenic turnout. Great view of the Straight Cliffs Formation.
- 0.9 27.2 Pet Hollow Junction. **Stay on highway.** We are now crossing the Alvey syncline, which is very broad here.
- 2.2 29.4 Main Canyon Junction. County road to left provides access to Main and North Creek Canyons in Dixie National Forest. The Main Canyon road provides access over the Escalante Mountains to Widtsoe Junction in Johns Valley. **Continue on Utah State Highway 12.** The strata now dip westward. The Tropic Shale crops out under the Straight Cliffs Formation to the left, and the rocks get older from here into the town of Escalante. Landslides on the right are developed on the Tropic Shale.
- 1.1 30.5 The Dakota Formation reappears left and right.
- 0.5 31.0 The variegated shale slopes of the Brushy Basin Member of the Morrison Formation crop out under the Dakota Formation.
- 0.8 31.8 Road drops into the Salt Wash Member of the Morrison Formation.
- 0.2 32.0 Take time to look northward. The white sandstone in the foreground is the Escalante Member of the Entrada. The deep red beds above are of the Tidwell Member of the Morrison, which are overlain by light brown sandstone ledges of the Salt Wash Member. The Upper Jurassic Tidwell Member was previously mapped as the Middle Jurassic Summerville Formation.
- 0.6 32.6 Road Junction to left. This road provides access to the Wide Hollow Reservoir and Petrified Forest State Park. The Salt Wash Member contains large logs of petrified wood, which can be seen at the State Park (see Morgan and others, 2000). To the right on Utah State Highway 12 are Salt Wash Member outcrops under which the Tidwell Member appears. **Stay on Utah State Highway 12.**
- 0.4 33.0 The road cuts at the west end of town are in the eolian Escalante Member of the Entrada Sandstone. **Please watch your speed carefully** because the Escalante police diligently patrol the road for speeding violations (even for a couple miles per hour over the posted limit).
- 0.8 33.8 Junction with road to right. This road provides access to the Kaiparowits Plateau through Alvey Wash, continues across the plateau to Warm Creek, and thence to Big Water. **Continue into town on Utah State Highway 12.**

- 0.8 34.6 East end of Escalante City at junction with Pine Creek Road, which turns off to the north (left). It provides access to the Hells Backbone Road. **Continue east on Utah State Highway 12.**
- 0.6 35.2 Escalante High School left.
- 0.2 35.4 **STOP 4.** Escalante monocline. **Turn left** into cemetery parking lot. Look north along the Escalante monocline. The Navajo Sandstone bends sharply to the west. To the left of the monocline are outcrops of the Escalante Member of the Entrada (white) overlain by the reddish Tidwell and ledgy Salt Wash Members of the Morrison Formation. Road to right extending east from the cemetery provides access to the Escalante River trailhead. **Return to highway and continue to Boulder, Utah.**
- 0.1 35.5 To the right of State Highway 12 is a nice view of the Straight Cliffs or Fiftymile Mountain. The highway now continues southeastward along the flank of the Escalante monocline, which dips gently at this location.
- 0.7 36.2 Pass Utah Department of Transportation facilities turnoff to the right. The highway has the gray chippy limestones of the Paria River Member to the left and the reddish Winsor Member of the Carmel Formation to the right. **Stay on Utah State Highway 12**
- 1.2 37.4 Sawmill turnoff. **Stay on Utah State Highway 12.**
- 1.9 39.3 Hole-in-the-Rock road junction to the right (leg of “Y” junction). See Hole-in-the-Rock Geologic Road Guide. Highway 12 bends northeastward. **Stay on Utah State Highway 12.**
- 0.5 39.8 Hole-in-the-Rock road junction to the right (other leg of “Y” junction). State Highway 12 now rises to Big Flat on Carmel and Page Formations.
- 4.2 44.0 Sharp turn, prepare to pull off at overlook on left side of the highway.
- 0.4 44.4 **STOP 5.** Escalante Canyons. Look eastward and see the Henry Mountains in the distance. The north mountain is Mt. Ellen, the middle mountain is Mt. Pennell, and the south mountain is Mt. Hillers. Bare-rock outcrops of the Navajo Sandstone in the foreground. Look across the highway at the cliff behind you. The truncated cross-beds mark an unconformity, above which are rocks of the Page Sandstone. Look towards the communications tower back up the road. The reddish slopes and sandstone represent intertonguing Page Sandstone and Carmel Formation. The communications tower itself is on the Paria River Member of the Carmel Formation--a red slope capped by white or light-gray chippy-weathering limestone. After the stop, the road descends into the Navajo Sandstone.

- 0.6 45.0 Spencer Flat Junction. **Turn right onto dirt road** (Note, if you wish you can omit this side trip by skipping ahead to milepost 55.2). Road is on Navajo Sandstone outcrops and eolian sand that fills hollows in the Navajo. **Stay on the main dirt road.**
- 0.9 45.9 Road descends into a mixed eolian and alluvial sand deposit (Qea) flat called Little Flat. On right are Page-Carmel outcrops.
- 0.5 46.4 Corral junction, **keep right.**
- 0.1 46.5 Cut and rise in road is in Page and Carmel outcrops.
- 0.3 46.8 View of Fiftymile Mountain and Navajo Mountain to the right in the distance.
- 0.2 47.0 Road cut to the right in the red Judd Hollow Tongue and the Page Sandstone above the Navajo Sandstone. The Navajo is exposed to the left with eolian sand filling hollows. Another view of Fiftymile Mountain and Navajo Mountain to the right.
- 0.3 47.3 Road drops on to Navajo Sandstone outcrops and hollows filled with eolian sand. The reddish material in the road is from a borrow pit in the Judd Hollow Tongue.
- 1.7 49.0 Road drops into Big Spencer Flat.
- 0.8 49.8 Large isolated bare-rock Navajo outcrop to right.
- 0.7 50.5 Junction to left, **continue straight ahead.**
- 0.4 50.9 Junction to right, **continue straight ahead.**
- 0.1 51.0 **STOP 6.** Moki marbles. Look for bare rock Navajo to the left of road covered with many black or very dark brown materials. Stop and look at Moki marbles or iron concretions and sheets of iron oxide-cemented sandstone. These special deposits are a product of chemical reactions in the ground water in which dissolved iron is precipitated forming concretions (Doelling, 1968; Anderson and others, 2000; Chan and others, 2000). Most of the Moki marbles (spherical objects) consist of an outer rind inside of which loosely or non-cemented sand can be found. Analyses of the rinds show a 15 percent iron content. The fact that Moki marbles are dark colored, spherical, and weather out on the outcrop (they tend to be more resistant than the surrounding sandstone) makes them very noticeable. **Remember the monument is closed to collecting.** Look and enjoy. If you need to take one home, photograph it. **Return to Utah State Highway 12.**



- 5.9 56.9 Junction with Utah State Highway 12, **turn sharply right**. Watch arrows as highway makes a sharp left turn. The road cuts into cross-bedded Navajo Sandstone.
- 2.7 59.6 Road drops into the Escalante River drainage.
- 0.4 60.0 Escalante Canyon overlook on left side of highway. If you wish to stop here, you will see the confluence of Calf Creek and Escalante River below. The Kayenta Formation (reddish-brown ledgy rocks) is at river level and is overlain by lower part of Navajo Sandstone (light cross-bedded sandstones).
- 0.3 60.3 Highway drops onto Kayenta Formation. Notice the high gravels of a river terrace on the left.
- 0.5 60.8 Highway crosses Escalante River and proceeds up the canyon of Calf Creek. The rocks adjacent to the highway are the red ledgy beds of the Kayenta Formation.
- 0.6 61.4 Cross Calf Creek. The light rock above is the Navajo Sandstone. Orange beds in the Kayenta are eolian sandstone.
- 0.6 62.0 Junction left to Calf Creek Campground. Road rises back into the Navajo Sandstone. If you have the time, drive into the campground, park, and take the 2-mile hike to the lower Calf Creek Falls. The scenery along the way is spectacular. During torrential rainfall, waterfalls cascade from the cliffs on both sides of the canyon.
- 0.5 62.5 Notice the old road cut to the left.
- 2.7 65.2 Trailhead parking on right. A trail begins on left side of highway for a hike to the lower Calf Creek Falls overlook. The trail is about 0.5 miles long, but does not go all the way into the canyon.
- 0.3 65.5 Carefully cross to the left side parking area for an overlook back into the Calf Creek and Escalante drainages. If you like the scenery developed in the Navajo Sandstone, you will enjoy this overlook.
- 0.4 65.9 Road snakes, go slow. Calf Creek drainage to the left, Boulder Creek drainage to the right.
- 0.7 66.6 New Home Bench. Note white caliche on bases of volcanic andesite boulders. Caliche slowly accumulates as part of the soil-forming process. Thick caliche indicates the deposits are hundreds of thousands of years old. View of Boulder Mountain ahead. Boulder Mountain is capped by volcanic lava flows. Below the upper surface of the mountain, the hummocky terrain consists of landslides floating large hunks of lava.

- 3.8 70.4 Junction; left to Hells Backbone. **Stay on pavement and keep right.** The Hells Backbone road provides access to Dixie National Forest. Hells Backbone is a precarious ridge in the Navajo Sandstone over which a bridge has been built. The road eventually joins with the Pine Creek Road, which leads back to Escalante (milepost 34.6 in Escalante). After passing the junction, the highway drops into a tributary of Boulder Creek. The road cut is in the Paria River Member of the Carmel Formation. As we cross the drainage around a "U" turn, the road is in the Page-Judd Hollow interval. The lower canyon cuts deeply into the Navajo Sandstone. After making the "U" turn, note the checkerboard pattern on the Navajo to the right.
- 1.1 71.5 Sharp "U" turn to the left after which the highway drops into the Boulder town area.
- 1.3 72.8 Cross Boulder Creek.
- 0.7 73.5 Burr Trail Junction, **turn left with highway.** If you wish to drive to the Burr Trail, see Circle Cliffs Geologic Road Guide.
- 0.6 74.1 Anasazi State Park. This park displays many relics of the Anasazi culture and is worth visiting. There is a museum and an outside display behind the building.

**END OF ROAD GUIDE**

## COLLET CANYON-CROTON ROAD

This geologic road guide connects with the Hole-in-the-Rock Geologic Road Guide at milepost 12.4. The road heads up Left Hand Collet Canyon and Lower Trail Canyon to Collet Top, hence southward down the Croton Road to the south end of the Kaiparowits Plateau, then drops onto the bench above Lake Powell, and ends in Big Water, Utah. **This is a very rough road requiring a four-wheel-drive, high-clearance vehicle. Do not attempt this road if you see thunderheads over the Kaiparowits Plateau, as Left Hand Collet is commonly host to horrendous flash floods.** This road is long and arduous. Be prepared to spend all day (it takes about 6 hours to drive this road without stopping) on this 74-mile long segment.

MILEAGE INTERVAL/CUMULATIVE	DESCRIPTION
0.0    0.0	The road begins at the junction of the Hole-in-the-Rock road and Collet Top Road on sand developed on the Entrada Sandstone. <b>Proceed west on Collet Top Road.</b>
0.2    0.2	Cross small tributary wash of Twentymile Wash and rise up on a sandy ridge. To left are outcrops of the Winsor Member of the Carmel Formation that exhibit criss-crossing gypsum veinlets. The road veers west after crossing the sandy ridge and parallels Twentymile Wash on the north edge of its valley.
0.4    0.6	The red-orange Gunsight Butte Member of the Entrada Sandstone can be seen to the right. Ahead, the Gunsight Butte beds are overlain by beds of the Cannonville Member of the Entrada.
0.4    1.0	Cross gulch.
0.3    1.3	Outcrops of Cannonville Member are to the right.
0.8    2.1	Outcrops of the Escalante Member of the Entrada are to the right with tafoni "stonepecker" holes!).
0.3    2.4	Capping the Escalante Member is the reddish band of the Tidwell Member of the Morrison Formation, which dips southwesterly into the Kaiparowits basin. Ledgy yellow-gray sandstone beds overlie the Tidwell and are assigned to the Salt Wash Member of the Morrison Formation. Ahead the brown and gray ledges and slopes of the Dakota Formation cap all.
0.2    2.6	Cross wash and continue up Left Hand Collet Canyon or Twentymile Wash.
0.4    3.0	In Salt Wash Member of the Morrison Formation capped by Dakota Formation.
0.5    3.5	Landslide ahead draping over the Dakota Formation.
0.2    3.7	Dakota Formation outcrops to the right and left.

- 0.3 4.0 Road is in the wash for a short while. Tropic Shale outcrops are to the left and right.
- 0.6 4.6 Tropic Shale outcrop immediately to the right of the road. This is a good place to carefully examine this marine shale unit. Note the abundant landslides on both sides of the wash. The Tropic is prone to landsliding. Small springs emerge in this part of the wash.
- 0.3 4.9 Leave wash temporarily. To the right is a landslide covering the Tropic Shale.
- 0.3 5.2 Look at hoodoos in the landslide to the right. The road is in and out of the wash. To the left, note the sandier upper part of the Tropic Shale. The first ledge above the thin-bedded sandy beds is the base of the Tibbet Canyon Member of the Straight Cliffs Formation. The contact is displayed on both sides of the canyon for one-half mile.
- 0.6 5.8 Top of the Tropic Shale is at road level to the left of the vehicle. You will be in the Straight Cliffs Formation from here on out in the canyon. Many of the sandstone ledges or cliffs are beach facies.
- 0.8 6.6 Overhang in the lower part of the Straight Cliffs Formation; pretty place.
- 0.4 7.0 Big rockfall boulder on left side of wash. Note the interesting honeycomb weathering in the sandstones in the canyon.
- 0.1 7.1 Small balanced rock on the right side of the wash was dubbed “Doelling Rock” by his assistants in 1970 (it’s all he’s worth). Honeycomb weathering pattern is well developed here. There is some conglomeratic sandstone in this part of the Straight Cliffs Formation.
- 0.3 7.4 Road to the right goes into Willard Canyon. **Do not take this road!** It is treacherous because of quicksand. **Continue straight ahead on main road to Collet Top.**
- 0.1 7.5 Road leaves Left Hand Collet wash for good. Hoorah! Road soon veers to the left (south) and proceeds up Lower Trail Canyon.
- 0.3 7.8 **STOP 1.** Christensen coal zone in the John Henry Member of the Straight Cliffs Formation. **Park automobile as far to the right as possible.** Start here on a short, somewhat strenuous hike along the south face of Left Hand Collet Canyon. Follow a thick coalbed to creek level. A thick coal zone will be exposed on the south side of the canyon with coal, carbonaceous shale, and other lithologies. A little bit farther up the wash, the wash floor is paved in coal. The Kaiparowits Plateau is underlain by thick coal beds of mostly high-volatile C bituminous coal (see Hettinger and others, 1996). **After the hike return to your vehicle** and continue up Lower Trail Canyon.

- 0.9 8.7 Notice the tapestry wall on the right interestingly coated with desert varnish.
- 0.4 9.1 Climb over a thin coalbed in the road.
- 0.1 9.2 A fluted pothole is present to the left.
- 0.7 9.9 Thick coalbed to the left of the road.
- 0.2 10.1 **STOP 2.** Alvey coal zone. Look down Lower Trail Canyon. Thick coalbeds are generally found above white ledges in the John Henry Member. Note the thick coalbed on the left side of the road (Alvey coal zone).
- 0.2 10.3 Rise through dugway cut into the Drip Tank Member of the Straight Cliffs Formation.
- 0.4 10.7 Junction at Collet Top is in wind-blown sandy and silty (loess) soils. Most of this area was chained to remove pygmy forest (Utah juniper and pinyon pine) and replanted with grasses to favor livestock. **Keep left at the junction, veering to southeast on Croton Road.**
- 0.8 11.5 Junction; **continue straight ahead on main Croton Road.** Many little side roads will extend left and right for the next few miles. Many of these roads are likely closed to vehicles. **Stay on the main road.** The upper surface of the Kaiparowits Plateau at this place is built on the Drip Tank Member of the Straight Cliffs Formation, a hard sandstone unit. The sandstone is commonly covered with Qea (mixed eolian and alluvial) deposits. Note Navajo Mountain in the distance to the southeast (straight ahead).
- 0.7 12.2 Cross cattle guard into pygmy forest (unchained area).
- 4.7 16.9 Road begins descent into John Henry Member of the Straight Cliffs Formation. Pink-stained sandstone represents rocks oxidized by coalbeds that have burned naturally along their outcrops. Shale baked during this process makes natural brick. Pieces of this natural brick make a clinkery sound when falling on each other. Hence such baked rocks are known as clinker. Navajo Mountain is still visible ahead to the southeast. The high ridge at 11 o'clock is near the axis of the Rees Canyon anticline. To the northeast the strata dip into the Croton Canyon syncline. To the southwest they dip into the Last Chance syncline. The Kaiparowits Plateau is a warped tableland on which several north-trending to northwest-trending anticlines and synclines have developed. Regionally, all strata dip gently northward.
- 0.2 17.1 The large reddish areas from here south to the south end of the plateau are known as the Burning Hills. Most of the actual burning probably took place during the Pleistocene. However, there are several areas within the plateau where coalbeds still burn spontaneously.

- 1.1 18.2 To the left is the Croton Canyon drainage which roughly follows the Croton Canyon synclinal axis. The rocks on the Kaiparowits Plateau beyond Croton Canyon rise again to the escarpment along Fiftymile Mountain (Straight Cliffs). There are no coalbeds on the far side of Croton Canyon and the John Henry Member of the Straight Cliffs Formation loses the coal-bearing lagoonal beds, and are replaced by beds deposited as beach and offshore sand. Many of these beach sandstone beds contain significant quantities of ilmenite and zirconium. The road follows the Rees Canyon anticlinal axis.
- 0.2 18.4 **STOP 3.** Open fractures. Get out of vehicle and examine open fractures in the sandstone. Walk out to the edge of the cliff to the right of the road. These fractures were developed as burning coal seams below were reduced to ash. The resulting reduction in volume (the coal contain less than 10% ash) caused the sandstone beds to collapse to fill the space. This commonly happens over underground mines as overlying rock collapses into the void created by mining. Continue on road.
- 0.5 18.9 **STOP 4.** Rees Canyon # 1 abandoned wildcat well site. Go to southwest edge of cliff. View to the west and southwest is over the Burning Hills into the drainage of Last Chance Creek. It roughly flows down the axis of the Last Chance syncline. Beyond the syncline the rocks rise again onto the Smoky Mountain anticline. At the north end of Smoky Mountain (anticlinal mountain) the hard cap of the Drip Tank Member is overlain by another set of cliffs. These upper cliffs of mudstone and sandstone are the Wahweap Formation. A sharp eye westward to the horizon will reveal the pointed peak of Mollies Nipple in the Grand Staircase section of the monument. The gap in the far distance to the southwest is the Echo Cliffs near the Arizona border. Table Cliff Plateau is visible to the north. Navajo Mountain is still in view to the southeast. Triassic and older rocks in many of the Kaiparowits Plateau anticlines have been tested for oil. Good oil shows were reported in most of the test holes, but only one anticline proved economical, the Upper Valley anticline. The Upper Valley anticline (see Cannonville to Boulder Geologic Road Guide mile 22.5), proved productive from the Permian Kaibab Limestone. Total production as of the end of 2000 for the Upper Valley field was over 26 million barrels of oil (Utah Division of Oil, Gas, and Mining production records). All the unproductive wells were drilled on the anticlinal crests, but the oil in the Upper Valley field was found down the southwest flank; the oil is flushed into the steep southwest flank by a strong water drive. None of the other anticlines in the Kaiparowits Plateau were tested along the flanks, including the well drilled at this location to exploit the crest of the Rees Canyon anticline.
- 0.4 19.3 Junction; **turn hard right.** The other road may appear to be in better condition but leads to several dead-ends.
- 2.4 21.7 Ancient coal fires ravaged these hills. Note that the amount of vegetation has declined.

- 1.4 23.1 Cut to left is in a clinker zone. Plant matter in yellow clinker is burned red. Cretaceous twigs, reeds, and other organic debris can be identified.
- 2.2 25.3 As road loses altitude, the end of Fiftymile Mountain and Navajo Mountain are nicely visible ahead.
- 1.5 26.8 First glimpse of Lake Powell to southwest.
- 0.9 27.7 Coalbed to the left of the road.
- 0.7 28.4 **STOP 5.** Burning Coal area. Park your vehicle along the Croton Road at the junction with small dirt road. The small dirt road is now closed to vehicles. Visitors must hike 0.3 miles to the burning coal area. This is an area of active underground coal fires. Creosote-like smelling gases emerge from some of the cracks. Walk about to places where you see steam or heat emerging. In some places the vegetation near the fractures is coated with black gooey coal oil. This and other fires burning on the plateau can best be detected in the winter when the cold air converts moisture rising with the coal gases to fog. On cold frosty days smoke can be seen emerging from many distant orifices. Many years ago the U. S. Bureau of Mines tried to douse this fire by covering cracks with overburden to snuff out the oxygen. The effort was to no avail. New cracks opened up and the fires continue. The flat sandstone used for a vehicle turn-around contains high-grade zirconium. **Return to the main road and vehicle.**
- 1.2 29.6 Road begins descent into drainage in coal-burned John Henry Member.
- 0.4 30.0 Black rock in the gulch to right is clinker that has partially melted. The heat has partly metamorphosed some of the rock that contains some sedimentary features that have not been altered. This rock is igneous, metamorphic, and sedimentary! Imagine the temperatures reached to create this rock.
- 0.5 30.5 **STOP 6.** Road overlook to the east. Fiftymile Mountain and Navajo Mountain can be seen in the distance. Look down at the Tropic Shale. Notice the huge hummocky landslide in the middle ground. The anticline between Navajo Mountain and this place is the Rock Creek anticline. The whaleback surface of the anticline is of the Salt Wash Member of the Morrison Formation.
- 0.4 30.9 **STOP 6A.** Road overlook to the east like the last one. Enjoy!
- 0.6 31.5 **STOP 6B.** Road overlook to the east like the last one. Enjoy!
- 0.3 31.8 Road begins final descent off the south end of the Kaiparowits Plateau. **Drive carefully.**

- 0.7 32.5 **STOP 7.** Top of a (scary) dugway on the Smoky Hollow Member of the Straight Cliffs Formation and view of Lake Powell to the south. The road will adventurously take us through the Smoky Hollow and Tippet Canyon Members of the Straight Cliffs onto a landslide developed on the Tropic Shale. Note the reddish oxidized material from the John Henry Member in the landslide debris below. Benches above Lake Powell are Salt Wash Member of the Morrison Formation. Along the dugway, we first proceed through the Smoky Hollow Member with the white Calico bed (Peterson 1969b) at the base. You will reach a bench developed on landslide at the base of the Straight Cliffs Formation. The descent through the dugway may be treacherous. **It may be wise to walk down a short distance to determine the condition of the road through this “adventure spot.”**
- 0.4 32.9 On landslide bench. The road now loses elevation on landslides developed on the Tropic Shale.
- 1.6 34.5 Large hoodoo to right in the landslide. Look across the drainage to the bright red coloration in the landslide brought down from the John Henry Member of the Straight Cliffs Formation. We now begin the last series of switchbacks to get all the way down.
- 0.4 34.9 Cross wash and we are down!
- 0.5 35.4 Road commences to climb hill in the Dakota Formation.
- 0.3 35.7 Thin Dakota Formation coalbeds over pink sandstone of the Morrison Formation to left and right.
- 0.8 36.5 The road is now on the Salt Wash Member of the Morrison Formation.
- 0.1 36.6 "T" road junction. **Turn right.** For the next several miles the road will alternate being on the ledgy Salt Wash sandstones and the coal-bearing Dakota. A few landslide deposits will be thrown in for variety.
- 1.6 38.2 Cross wash. White to light-gray sandstone of the Salt Wash Member of the Morrison Formation is unconformably beneath the brown and gray beds of the Dakota Formation. The contact is sharp with cut-and-fill structures.
- 1.4 39.6 The road is now on the Tropic Shale and begins veering northward into the deep Last Chance Canyon re-entrant.
- 2.1 41.7 The road drops back into the Dakota Formation.
- 1.1 42.8 Cross Last Chance Creek in the Salt Wash Member of the Morrison Formation. Road returns quickly into the Dakota Formation.



- 4.9 47.7 Road turns to traverse south end of Smoky Mountain, mostly on Dakota Formation with some incursions onto the Tropic Shale. Look for very dark gray to black moonscape Tropic Shale to the right. Scenes from the “Planet of the Apes” movies and “The Greatest Story Ever Told” were filmed near here.
- 10.9 58.6 Junction with Alvey Wash Road and the Kelly Grade from Escalante to the right. **Continue westward toward Big Water.**
- 0.6 59.2 Cross Warm Creek wash.
- 0.5 59.7 Junction with Warm Creek Road. **Keep left.**
- 3.7 63.4 Crosby Canyon Junction. Road left provides access to Lake Powell. **Continue straight ahead.**
- 5.6 69.0 Balanced rocks (rock-fall boulders) in the Tropic Shale to the right.
- 2.8 71.8 Cross Wahweap Creek below Big Water.
- 0.7 72.5 Junction, **turn left** at top of hill on Wahweap Creek terrace gravel deposit.
- 0.3 72.8 Junction at U.S. 89. **Turn right** to go to Kanab, turn left to go to Glen Canyon Dam and Page, Arizona. (see Kanab to Big Water Geologic Road Guide)

**END OF ROAD GUIDE**

## ALVEY WASH - SMOKY MOUNTAIN ROAD

This geologic road guide is along a county road that may be very rough. A high-clearance, four-wheel-drive vehicle is recommended, and sometimes required, depending upon how recently maintenance has been performed on the road. To run the full length of the road guide generally takes four hours or longer. If the traveler stops often, such as for photo opportunities or to examine outcrops, this trip can easily take all day. The distance to Big Water, without side trips, is about 80 miles. Carry sufficient water, food, and gasoline for the trip. The length of this road guide is about 64 miles.

This geologic road guide commences at Main Street and 500 West in the town of Escalante, Garfield County, Utah, and travels south along Alvey Wash. After leaving Alvey Wash, the road crosses the Kaiparowits Plateau via Smoky Mountain and winds down the Kelly Grade onto Grand Bench above Lake Powell. The road guide ends at the junction with the Croton Road (see Collet Canyon-Croton Geologic Road Guide). The road continues on southwest to Big Water, Utah, on U.S. Highway 89. This guide concentrates on the roadside geology rather than on the historical aspects of the route.

<b>MILEAGE INTERVAL/CUMULATIVE</b>	<b>DESCRIPTION</b>
0.0    0.0	<b>Go south</b> at the corner of Main Street and 500 West in Escalante, Utah.
0.6    0.6	Road veers southwest and then west; pavement ends.
0.3    0.9	Road heads southwest again passing through Morrison Formation. The Morrison Formation is of fluvial origin. Both the lower Salt Wash Member (sandstone and minor mudstone and conglomerate) and the upper Brushy Basin Member (mudstone containing a few thin interbeds of sandstone and conglomerate) of the Morrison Formation are present at Escalante; however, the Brushy Basin Member pinches out before the Kane County line (Davidson, 1967; Doelling and Davis, 1989)
0.4    1.3	Small butte at 9 o'clock is composed of the Morrison Formation. The red lower unit is the Tidwell Member overlain by the massive-weathering sandstone of the Salt Wash Member.
0.5    1.8	<b>STOP 1.</b> Ledge on the right side of the road and at 10 o'clock is Dakota Formation. The age of the Dakota Formation has been considered early Late Cretaceous (Davidson, 1967), but there is evidence that the lower member is late Early Cretaceous (Doelling and Davis, 1989). Thus, the lower member may represent beds of the Cedar Mountain Formation. The depositional environment for the Dakota Formation varies from fluvial to marine; the lower member being fluvial, the middle member consisting of interbedded sandstone, mudstone, and coal-bearing lagoonal deposits; and the upper member being brackish-water and marine deposits (Doelling and Davis, 1989). The Dakota Formation varies from 100 to 200 feet in thickness in the monument area (Hintze, 1988).

At 11 o'clock is a slope of Tropic Shale below the foot of the massive ledge of Tibbet Canyon Member of the Straight Cliffs Formation and above the Dakota Formation. The Tropic Shale, a unit of marine origin, is thinly laminated to thin-bedded mudstone and shale with lesser amounts of sandstone, bentonitic claystone, siltstone, and limestone. It ranges in thickness from about 700 to 1,000 feet throughout the region and forms slopes, which are commonly covered with colluvium or landslide debris.

The Straight Cliffs Formation is exposed around the edges of the Kaiparowits Plateau, particularly along the Straight Cliffs for which it was named. It is Late Cretaceous in age and has been divided into four members in this area by Peterson (1969a, 1969b). The lowest member is a cliff-forming yellowish-gray to grayish-orange beach and shallow marine sandstone called the Tibbet Canyon Member. Above the Tibbet Canyon is the Smoky Hollow Member, a non-marine unit of cliff- and slope-forming sandstone, mudstone, carbonaceous mudstone, and coal. In most areas, it is capped by the 0- to 51-foot Calico bed (Peterson 1969b). An unconformity separates the Smoky Hollow Member from the John Henry Member, which is also a cliff- and slope-forming unit of interbedded sandstone, mudstone, carbonaceous mudstone, and coal. According to Peterson (1969a, 1969b), the John Henry Member is composed of "a predominately nonmarine facies in the southwestern and central part of the region and a predominantly marine facies in the northeastern part." The Drip Tank Member forms the top unit of the Straight Cliffs Formation. It is a pale-yellowish-brown to grayish-orange sandstone with features suggesting a fluvial environment. The Straight Cliffs Formation averages 1,400 feet thick in the area of Left Hand Collett Canyon (Doelling and Davis, 1989).

- 0.3    2.1    Grand Staircase-Escalante National Monument sign.
- 0.5    2.6    Alvey Wash Crossing.
- 0.8    3.4    Tibbet Canyon Member at road level on left.
- 0.5    3.9    Alvey Wash Crossing.
- 0.4    4.3    Cross Alvey Wash again.
- 0.1    4.4    Coal Bed Canyon on right. The Shurtz mine and Christensen mine are located in Coal Bed Canyon. These mines operated in the latter part of the 19<sup>th</sup> century and the early part of the 20<sup>th</sup> century, supplying coal for local needs. The Christensen mine reportedly operated continually from 1893 to 1930, producing about 100 tons of coal per year. The Shurtz mine reportedly operated between 1913 and 1928, also producing about 100 tons of coal per year (Doelling and Graham, 1972, p. 92).
- 0.4    4.8    Coal-mine dump or prospect on right.

- 0.1 4.9 Rocks are John Henry Member.
- 0.7 5.6 Calf Canyon on the left at 9 o'clock.
- 0.2 5.8 Note the downcutting through alluvial material in the recent past, and invasion of non-native plants such as tamarisk and Russian olive.
- 1.0 6.8 Ledges on the left and right are Drip Tank Member of the Straight Cliffs Formation.
- 0.2 7.0 Dave Canyon on the left. Drip Tank Member at 12 o'clock.
- 0.5 7.5 Horse Spring Canyon on the right at 3 o'clock.
- 0.6 8.1 Continuing along the route the Drip Tank Member of the Straight Cliffs Formation forms the cliffs on each side. Above the Drip Tank is the base of Wahweap Formation. The Wahweap Formation is a slope- and cliff-forming interbedded unit of sandstone and mudstone lying conformably on top of the Drip Tank Member of the Straight Cliffs Formation. The Wahweap is considered to have been deposited in a fluvial environment for the most part. It is divided informally into lower and upper members with a total thickness in excess of 1,000 feet throughout most of the monument.
- 1.0 9.1 Sign marking the Death Ridge and Big Sage Junction. **Stay to the left.**
- 0.3 9.4 Driving in lower Wahweap Formation. Top of butte at 9 o'clock is upper Wahweap.
- 0.3 9.7 Bull Run Canyon on left.
- 1.9 11.6 Looking up the Bull Run Canyon at 3 o'clock, you see lower Wahweap with upper Wahweap at the top of the ridge.
- 0.3 11.9 Small road or trail that extends to the left. This small road is closed. **Stay on main Alvey Wash Road**
- 0.1 12.0 Wash bottom.
- 2.0 14.0 Driving onto Camp Flat on lower Wahweap Formation.
- 0.4 14.4 Small road extends to the left. **Stay on main Alvey Wash Road.**
- 0.2 14.6 Head of Sarah Ann Canyon.
- 0.4 15.0 Small road extends to the left. **Stay on main Alvey Wash Road.**
- 0.2 15.2 Small road extends to the left. **Stay on main Alvey Wash Road.**

- 0.9 16.1 Sandstone bed in small canyon to the left is the Drip Tank Member.
- 0.2 16.3 West flank of the north extension of the Rees Canyon anticline.
- 0.9 17.2 Road crosses wash bottom.
- 0.2 17.4 Drip Tank Member crops out in the canyon to the left. The ridgeline coincides with the crest of the anticline.
- 0.3 17.7 Note the chained area to the left is on the lower Wahweap Formation. In the past, land managers used the method of chaining to rip down pinyon-juniper stands in order to improve the amount and quality of forage for livestock and wildlife.
- 0.3 18.0 Road crosses culvert.
- 0.6 18.6 Pullout area with small road that extends to the right. The road that goes to the right leads to Right Hand Collett Canyon. **Stay on main dirt road; do not take the road to the right.**
- 0.3 18.9 Terrace gravels.
- 0.3 19.2 Drip Tank Member of the Straight Cliffs Formation crops out in the canyon to the left. The beds dip into a broad anticline.
- 0.8 20.0 Road crosses a wash. Right Hand Collett Canyon to side. This area can be a flood hazard.
- 1.6 21.6 Crest of hill. A small road extends to the left. **Continue on main Alvey Wash Road** atop the lower Wahweap.
- 1.2 22.8 Head of Long Canyon on left, pond on right, still in the lower Wahweap.
- 0.4 23.2 Beginning of Big Sage Flat.
- 1.1 24.3 Henry Mountains in view at 10 o'clock. The upper edge of the Straight Cliffs is on skyline between 8 and 11 o'clock.
- 1.4 25.7 Small road extends to the left. **Stay on main dirt road.**
- 1.1 26.8 Fence and cattle guard.
- 0.4 27.2 Yet another road extends to the left. **Stay on main dirt road.**
- 1.5 28.7 Head of Left Hand Collett Canyon.

- 0.2 28.9 Brass survey marker cap to the left of the road and just before the fence and cattle guard. The brass marker defines the common corner of sections 25, 26, 35, and 36, T. 38 S., R. 3 E. We are on the Drip Tank Member here.
- 0.3 29.2 Landslides, including slumps, are mapped west of the road in this area.
- 2.6 31.8 Rim of the canyon to the left is formed by the Drip Tank Member.
- 0.3 32.1 Junction. Road going east (left) down the fence line leads to the Left Hand Collett-Croton Canyon road junction. **Take the Smoky Mountain Road to the right.**
- 1.5 33.6 Entering Pete's Cove. The Wahweap Formation is all you see to the right at 2 o'clock.
- 1.4 35.0 Fence and cattle guard. This is the head of Dry Wash. The Drip Tank Member of the Straight Cliffs Formation forms the canyon rim and bench above the canyon.
- 3.7 38.7 Dry Bench ahead at 11 o'clock.
- 0.4 39.1 Fence and cattle guard. The small road that runs southwest leads to Caine Bench. **Stay on main dirt road.**
- 0.4 39.5 Road running off to the south. **Stay on main dirt road.**
- 2.3 41.8 Driving on the Drip Tank Member. Reynolds Point is in view at 1 o'clock.
- 0.7 42.5 Last Chance Creek.
- 0.1 42.6 Shady spot under the cottonwood trees. Terrace gravel deposits lie above the creek bed.
- 1.6 44.2 Driving on the lower member of the Wahweap Formation.
- 0.5 44.7 Drip Tank Canyon is to the left. At 10 o'clock, the lower Wahweap Formation forms an anticlinal ridge at the north end of the Smoky Mountain anticline.
- 0.7 45.4 Drip Tank Canyon wash bottom. The type section for the Drip Tank Member is down stream on the north side of the canyon (NE1/4, NE1/4, section 24, T. 40 S., R. 3 E.).
- 3.3 48.7 Junction of Smoky Mountain and Heads of the Creek Roads. The Heads of the Creek Road goes to the right. **Continue straight ahead on the Smoky Mountain Road.**

- 0.7 49.4 **STOP 2.** Pilot Knoll. Take a short hike to the top of Pilot Knoll, which sits just west of the road. Looking east one can view the Croton Canyon syncline (near distance), Rees Canyon anticline (middle distance), and Fiftymile Mountain on the far horizon. Navajo Mountain lies to the southeast. The road generally follows the crest of the Smoky Mountain anticline – Smoky Mountain is an anticlinal ridge. Looking farther south one sees the Navajo Power Plant. Looking due south is Smoky Hollow. View to the northwest is Pilot Rock in the foreground and Ship Mountain Point in the background.
- 1.9 51.3 Junction. Road to the right goes down Smoky Hollow Canyon. **Continue straight ahead on the Smoky Mountain Road.**
- 2.6 53.9 A small road leads to the knoll on the left. **Stay to the right on the main dirt road.** Some of the trails leading east from Smoky Mountain Road here lead short distances to areas of active, naturally ignited coal fires. The area around the fires can be hazardous, containing open fractures and vents of noxious gas.
- 2.4 56.3 **STOP 3.** South end of Smoky Mountain. Beginning of Kelly Grade. The view off into Lake Powell and Glen Canyon Recreation Area is from the top of the Drip Tank Member. The rock outcrops to the southeast in the foreground belong to the John Henry Member of the Straight Cliffs Formation. The reddish brown color is due to naturally burned coalbeds, which ignited during centuries past. The rocks surrounding Lake Powell are Jurassic in age. Bench between the lake and the plateau is comprised of the Entrada (lighter colored unit below) and Dakota Formations. **Start down Kelly Grade.**
- 0.8 57.1 Coalbed in the John Henry Member of the Straight Cliffs Formation is very weathered.
- 0.5 57.6 The overlook of John Henry Member of the Straight Cliffs Formation at 2 o'clock shows alternating cliffs and slopes with some oxidized and some unoxidized coalbeds. The Tibbet Canyon Member forms the shear cliffs just above the valley floor. The Smoky Hollow Member overlies the Tibbet Canyon Member. The lower slopes and valley floor are comprised of the Tropic Shale.
- 0.3 57.9 Oxidized sandstone at 12 o'clock.
- 0.3 58.2 Thick coalbeds of the John Henry Member of the Straight Cliffs Formation.
- 0.2 58.4 The Calico bed (Peterson, 1969b) that lies at the top of the Smoky Hollow Member of the Straight Cliffs Formation is to the left of the vehicle. This unit stands out when viewed across the canyon. Dinosaur track casts are sometimes found in the beds above the "calico bed."
- 0.6 59.0 Driving on or near the top of the Tibbet Canyon Member. Coalbed in the Smoky Hollow Member is on the left.

- 0.4 59.4 Overlook to Lake Powell. To the east are slumps and landslides caused by mass wasting of units above the Tropic Shale.
- 1.3 60.7 Wash bottom and the end of Kelly Grade.
- 0.7 61.4 At 2 to 3 o'clock, one can see Tropic Shale capped by sandstone of the Tippet Canyon Member of the Straight Cliffs Formation.
- 1.7 63.1 Junction with Croton Road to the left. See the Collet Canyon-Croton Road Geologic Road Guide for geologic descriptions from here to Big Water, Utah.
- 1.1 64.2 Junction of Smoky Hollow and Tippet Canyon Roads to the right. **Stay on main road** to Big Water, Utah.

**END OF ROAD GUIDE**



## KITCHEN CORRAL WASH

This geologic road guide begins at Milepost 37 and mile 28.1 on the Kanab to Big Water road guide, on U.S. Highway 89, east of Kanab, Kane County, Utah. The road begins at the junction of U.S. Highway 89 and a county road that extends northward along Kitchen Corral Wash. The first few miles of the route are passable by a two-wheel-drive vehicle. However, parts of the last few miles of the route, as noted in the guide, pass through deep sand requiring four-wheel-drive in a high-clearance vehicle. The route passes through several washes that can be dangerous during periods of high rainfall.

<b>MILEAGE INTERVAL/CUMULATIVE</b>	<b>DESCRIPTION</b>
0.0    0.0	Junction of U.S. Highway 89 and the Kitchen Corral Wash Road. <b>Turn onto the Kitchen Corral Wash Road and proceed north.</b> Quaternary (Pleistocene) terrace gravels from Kitchen Corral Wash drainage cover the hills adjacent and to the right of the road. Visible on the south side of U.S. Highway 89 at the junction, the Permian-age Kaibab Formation forms the top of the deep canyon known as Buckskin Gulch. Buckskin Gulch begins at this point and follows a south-southeast path to its confluence with the Paria River.
1.5    1.5	Traveling north on the Kitchen Corral Wash Road, at approximately the 9 o'clock position, the upper portion of the Lower Triassic Moenkopi Formation forms the low reddish-brown ridges at the base of the Vermilion Cliffs. The light-colored unit capping these low ridges is the Upper Triassic Shinarump Member of the Chinle Formation.
1.8    3.3	Junction of Kitchen Corral Wash Road and Manganese King Mine Road. At 1 o'clock the tan colored Shinarump and the mauve-colored Petrified Forest Member of the Chinle Formation crop out. For a side journey to the Manganese King mine, park your vehicle on the Kitchen Corral Wash Road and walk along the old mine road (about 0.5 miles) to the remnants of the old mine workings, which are visible in the Petrified Forest Member. An old ore-loading ramp built during the active mining period is still visible. Note that the Moenave Formation has rotated into an almost vertical position by sliding on the slippery muds of the Chinle Formation.

The history of the Manganese King mine began in 1908 with the discovery of manganese nodules. It was not until 1939 that their source was pinpointed. Active mining began in 1939 and continued through 1941, with intermittent operations through 1944. During this period of mining at least 191 tons of ore was shipped. The manganese occurs in a nodular form near the middle of the Petrified Forest Member. Nodules are predominately psilomelane and pyrolusite and range up to 4 or 5 inches in diameter with an average 1 or 2 inches. All mining ceased when Metals Reserve Corporation stopped buying ore after World War II. Manganese is essential to the steel industry and is used to desulfurize and deoxidize molten steel.

Looking east from the mine workings, Eight-mile Pass forms a prominent butte in the distance. The butte is composed of Dinosaur Canyon Member (lower portion) and Springdale Sandstone Member (massive cliff-forming upper unit) of the Jurassic Moenave Formation. These units form the classic Vermilion Cliffs section (riser) of the “Grand Staircase.”

- 0.2 3.5 Looking east, good exposures of the mauve and purple banded Petrified Forest Member of the Chinle Formation are visible.
- 0.5 4.0 At 9 o’clock, the cliff-forming Shinarump Member of the Chinle Formation crops out. The Shinarump is light-tan-gray, medium-grained fluvial sandstone. Cobbles of quartzite are also preserved in the Shinarump.
- 0.2 4.2 Evidence of mining activity (old timber works) in the Shinarump Member of the Chinle.
- 0.3 4.5 Good exposures of Shinarump are seen on east side of road. Looking in the drainage to the northwest, Quaternary alluvium (Qal) covers the Shinarump Member of the Chinle Formation.
- 0.9 5.4 Exposure of Petrified Forest Member of the Chinle. On the west side of the road, the Moenave Formation forms a large slump feature over the Chinle. **Turn off to right** to the “Rock House” constructed by Civilian Conservation Corps (CCC). The “Rock House” was used as a storage facility for ranching operations in the Kitchen Corral Wash area.
- 0.1 5.5 **Open gate that crosses main road and proceed** on (make sure gate is securely closed before proceeding).
- 0.7 6.2 Confluence of Deer Springs Wash and Kitchen Corral Wash at 11:00 o’clock.
- 0.8 7.0 White Cliffs are visible in the distance. The cliffs are Lower Jurassic Navajo Sandstone.
- 0.1 7.1 The juniper-pole corral on left (west) side of main road was constructed by the CCC.
- 0.4 7.5 Contact of Chinle and basal Moenave Formation (Dinosaur Canyon Member) is visible. This contact represents the J-0 unconformity, the first of five Jurassic unconformities in Utah and surrounding states identified by Pippingos and O’Sullivan (1978). The Springdale Sandstone Member of the Moenave Formation overlies the Dinosaur Canyon Member.

- 0.2 7.7 The road crosses a deep wash at the mouth of Box Elder Canyon. There are good examples of modern erosion in alluvial deposits here. However, beware of flash floods during the summer months!!
- 0.8 8.5 The large boulder along east side of roadway is from the Springdale Sandstone Member of the Moenave Formation. The Springdale Sandstone Member is massive, red-brown sandstone that forms the steep cliff face along the road. Ancient Puebloan (Anasazi) petroglyphs are carved on the face of the large boulder.
- 0.9 9.4 Contact of Moenave and overlying Kayenta Formation. Thin alternating beds, above the massive Springdale Sandstone Member of the Moenave Formation at 9 to 10 o'clock, are part of the Kayenta Formation.
- 0.5 9.9 Intersection of Deer Springs Ranch Road and Nipple Ranch Road. The Lamb Point Tongue of the Navajo Sandstone is overlain by the Tenney Canyon Tongue of the Kayenta Formation at 12 o'clock. **Stay to the right and go through gate.**
- 0.1 10.0 Contact of Kayenta (Tenney Canyon Tongue) and Lamb Point Tongue of the Navajo Sandstone. Two sandstone hoodoos are seen at top of cliff on left side of road.
- 1.0 11.0 At 10 o'clock is No Mans Mesa, which is formed by the Navajo Sandstone. At 1 o'clock, a prominent feature known as Mollie's Nipple (Navajo Sandstone) is in view. **Caution - road traverses through deep sand. Four-wheel-drive is highly recommended!**
- 1.5 12.5 The top of the hill and overlook of Nipple Lake and Nipple Ranch. Main road descends through deep sand into the South Swag. Powell Point on Table Cliff Plateau is seen on the distant horizon. Cannan Peak is seen at 1 o'clock on the horizon.
- 0.9 13.4 Tenney Canyon Tongue of the Kayenta Formation crops out ahead (at 12 o'clock). Main body of the Navajo Sandstone is above the Tenney Canyon Tongue.
- 0.4 13.8 Mollie's Nipple is in view at 3 o'clock. Iron-rich layers in the Navajo Sandstone form a resistive cap.
- 0.3 14.1 Remnants of the seasonal (ephemeral) Nipple Lake on right side (south) of road.
- 0.7 14.8 Junction of the Kitchen Canyon Road and the main (Kitchen Wash) road.
- 1.6 16.4 At 9 o'clock, the south end of Paunsaugunt Plateau is on west horizon. The colorful Pink Cliffs that are exposed along the Paunsaugunt Plateau are upper Paleocene to middle Eocene Claron Formation. This section of rock forms the

uppermost layer of the “Grand Staircase.” The main road travels along a ridge of Quaternary eolian deposits that are derived from the underlying Navajo Sandstone. North Swag and No Mans Mesa are seen to the west and south of the road.

- 1.0 17.4 Junction. **Stay on the main road.** The Paria River drainage is seen to the left. View of a portion of the “Grand Staircase” is seen by looking north and east (White Cliffs are Jurassic Navajo Sandstone; Gray Cliffs are upper Cretaceous formations; and the Pink Cliffs are Tertiary Claron Formation.)
- 1.4 18.8 End of the road guide is at an old wildcat well site; the Pan American Petroleum-Paria Operation Unit #1 and #1-A (N1/4, SE1/4, section 16, T. 40 S., R. 2 W.). A spectacular view is seen from this location of the heart of the upper Paria River drainage. To the north at approximately 1 o’clock, the confluence of Sheep Creek and the Paria River can be seen. The Paria River follows a sinuous path through the contrasting Navajo Sandstone, which is red colored in the lower part and white in the upper part of the formation.

## END OF ROAD GUIDE

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