

ROAD LOG 1 - GRAND JUNCTION TO FLOY EXIT

Compiled by

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Note: Many of the figures in this document were constructed from published sources and/or created independently by the author for field-trips for numerous petroleum and mining companies (e.g., Unocal, Kerr-McGee, Anadarko, Bowie Resources, Newfield, Encana, Bill Barret, Williams, Berry, C&C Energy, EOG, and Kosmos), professional organizations (AAPG, RMAG, UGS, SPE, and GSA) and private groups. Thus, some of the content herein may be considered proprietary. Please contact the author for more information (grandmesageoscience@gmail.com or rcole@coloradomesa.edu).

This segment provides a geologic driving summary from Canyon View Park in Grand Junction to the Floy Exit (#175) near Crescent Junction, Utah. A second, more detailed, road log from the Floy Exit to the stops in the Ten Mile Graben is provided in a separate handout. **Figure RL1-1** shows locations discussed herein. The I-70 exits and mile markers along the route are:

Exit 28 – 24 Road from Canyon View Park
Exit 26 – Junction of I-70, I-70B, and US 6 & 50
Exit 19 – Fruita
Exit 15 – Loma
Exit 11 -- Mack
Exit 2 -- Rabbit Valley
Exit to Harley Dome View Site (**Stop 1**)
Exit 227 – Westwater
Exit 221 – Sulphur (Enterprise Products, GJ Terminal)

Exit 214 – Danish Flat (**Stop 2**)
Exit 204 – Cisco (UT 128)
Exit 193 – Yellow Cat
Mile Marker 190 – Utah Welcome Center (**Stop 3**)
Exit 187 – Thompson Springs
Exit 182 – Crescent Jct. (US 191)
Exit 175 – Floy (**Stops 4-10**)

Since this field trip involves considerable driving, the goal of Road Log 1 is to provide insight into geologic features visible in the distance and various road cuts.

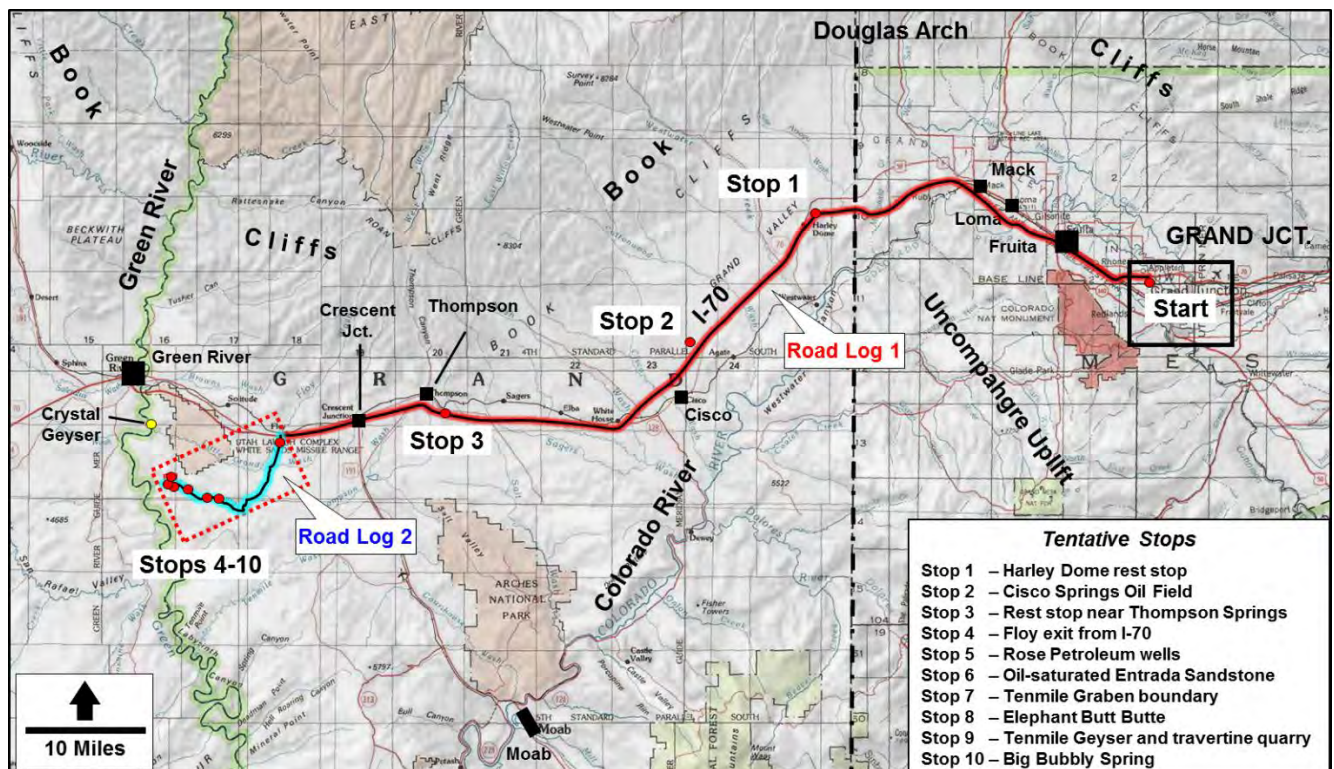
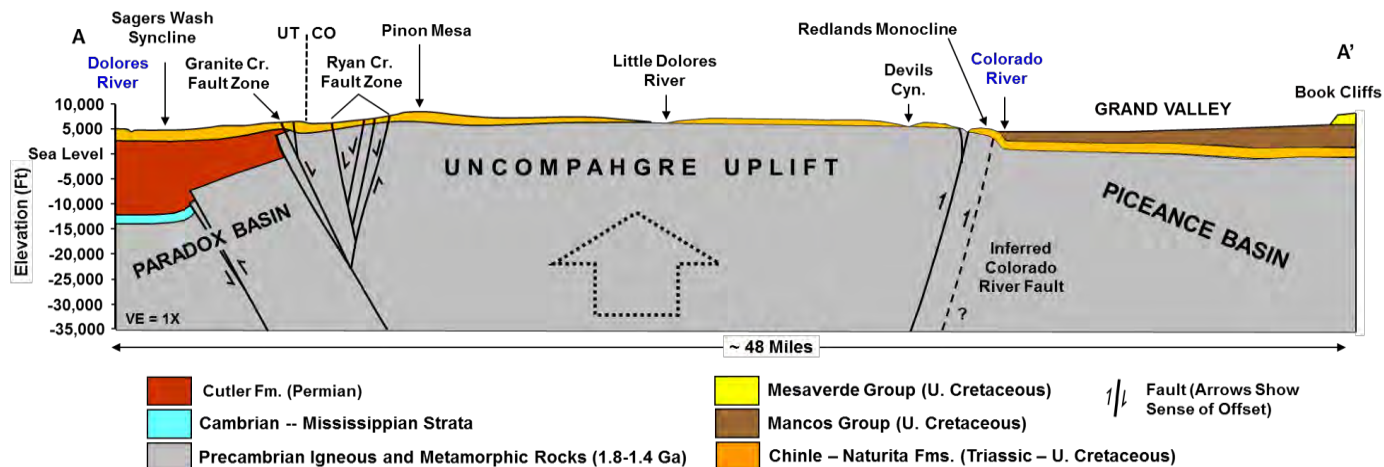
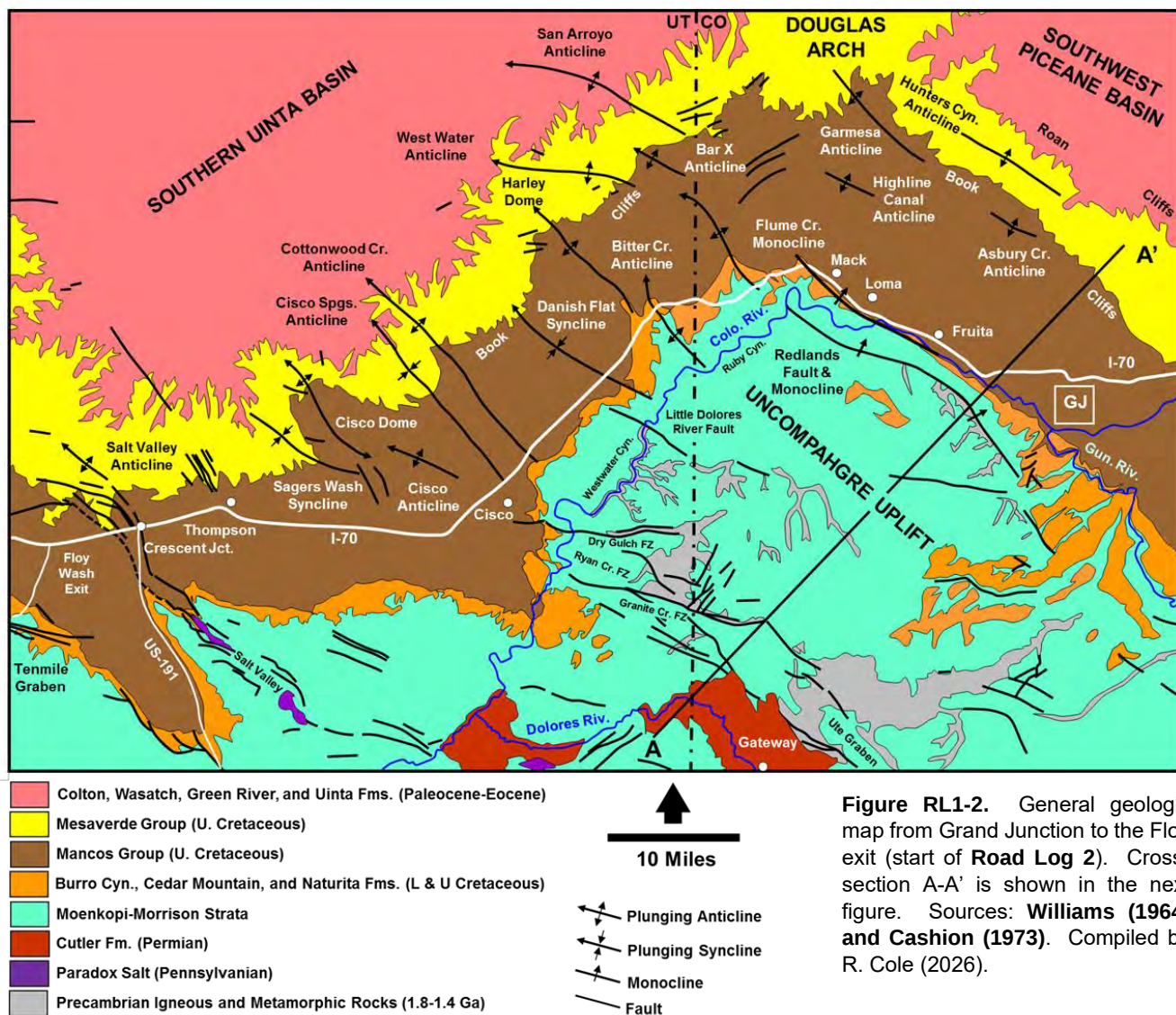


Figure RL1-1. Field-trip index map showing the route, stops, cultural features, and the extent of Road Logs 1 and 2. You are reading **Road Log 1**. **Road Log 2** is a separate pdf.

The I-70 route will traverse the Grand Valley, with views of the northwest Uncompahgre Uplift and the Book Cliffs to the northeast and north. **Figure RL1-2** provides a geologic map and **Figure RL1-3** is a geologic cross section from the Paradox Basin, over the Uncompahgre Uplift, and into the Piceance Basin. Note that most of the route is on the lower Mancos Shale, with several intersections of the Naturita (Dakota), Burro Canyon-Cedar Mountain, and Morrison.



During the drive west, the Book Cliffs will be continuously visible to the north, at distances ranging between 2 and 12 miles (they get closer near Thompson and Crescent Junction). The Book Cliffs extend from Price, UT, to Palisade, CO, and have been extensively studied for more than 70 years. Seminal work by the late Dr. Robert Young began the documentation in 1955. More than 100 publications have followed, mainly focusing on stratigraphy and sedimentology. The base of the Book Cliffs coincides with the transition from the Mancos Shale below to the Mesaverde Group above. Most of the cliff-forming strata consist of tabular shoreline sandbodies produced by progradation of wave-dominated deltas and strandlines (see **Figure BG-15**). A general stratigraphic cross section between Palisade and Green River, UT, is presented in **Figure RL1-4**. It should be noted that the nomenclature for Upper Cretaceous strata change at the State line (the “curse” of lithostratigraphy).

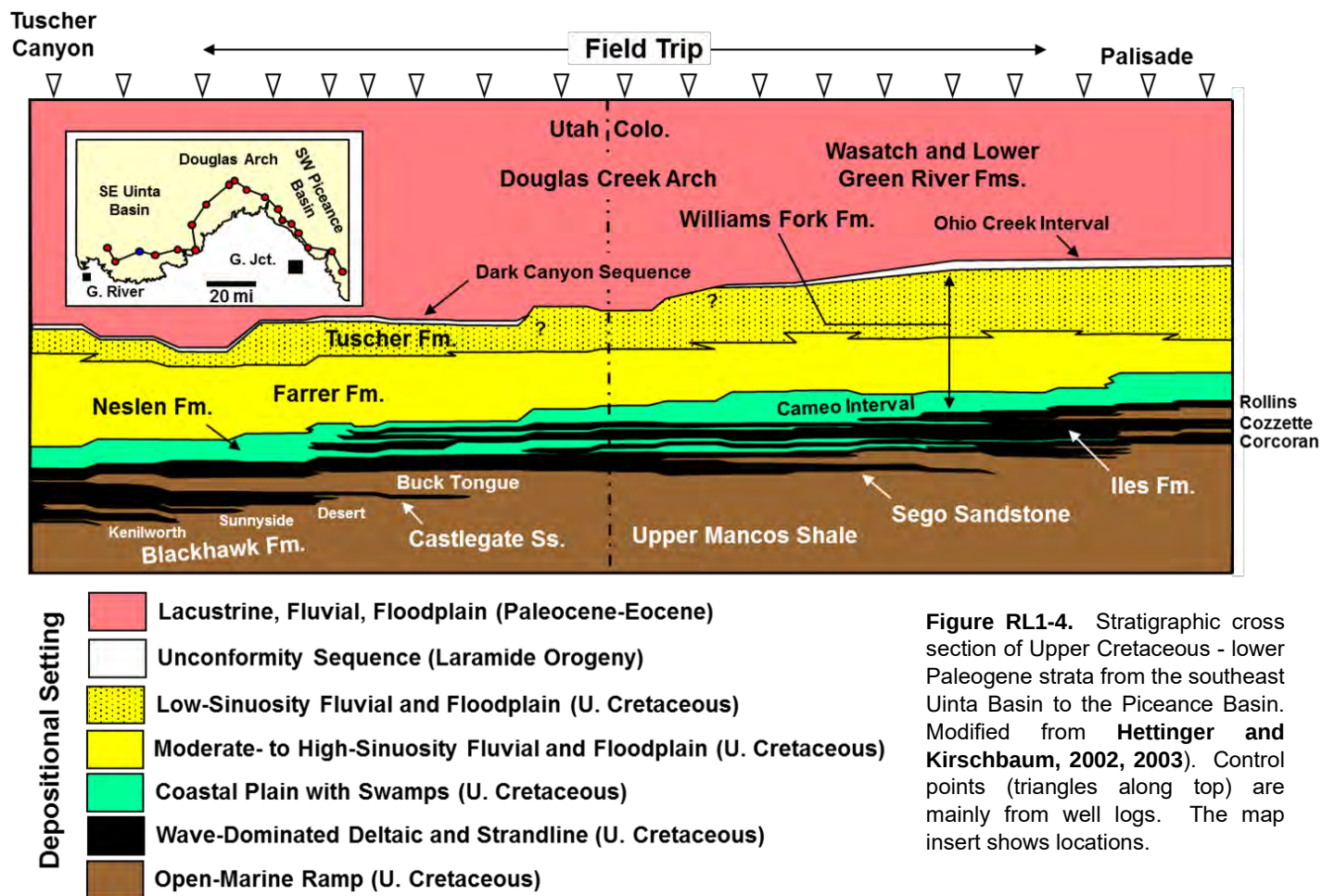


Figure RL1-4. Stratigraphic cross section of Upper Cretaceous - lower Paleogene strata from the southeast Uinta Basin to the Piceance Basin. Modified from **Hettinger and Kirschbaum, 2002, 2003**. Control points (triangles along top) are mainly from well logs. The map insert shows locations.

Canyon View Park to Fruita Exit (~8.5 mi)

Exit Canyon View Park onto westbound G Road. At the G Road-24 Road intersection (roundabout), continue north on 24 Road to I-70 (~0.5 mi). After negotiating the two roundabouts, take the westbound entrance onto I-70. [This is probably the most difficult driving test for the entire trip.] Continue west on I-70. There are two upcoming exits: Exit 26 is at the intersection with US 6 & 50 and the I-70 Business Loop, and Exit 19 is at Fruita. **Do not take either exit.**

Geology

Along this leg, the faulted southeastern front of the Uncompahgre Uplift provides a spectacular backdrop, familiar to many GJGS members. The scenic vista is partly within Colorado National Monument. Bill Hood is the resident expert on what you are seeing, having participated in the mapping of the Monument by the USGS (**Scott et al., 2001**) and by volunteering at the visitor center for many years. [Note - Rick Livaccari, Jim Johnson, and Rex Cole were also involved in the USGS mapping.]

The northeast front of the Uncompahgre Uplift is the structural boundary for the Piceance Basin and is defined by the Redlands Monocline and related Redlands Fault (**Figure RL1-5**). Both were created during the Laramide Orogeny. A close-up of the boundary in the Monument is also shown on the following geologic map (**Figure RL1-6**) and cross section (**Figure RL1-7**), both from **Scott et al. (2001)**. Note that the monocline consists of a series of large “wrinkles” and the fault is actually a fault system, with high-angle reverse displacement.

Figure RL1-5. Annotated aerial photograph of the northeast flank of the Uncompahgre Uplift in Colorado National Monument showing the Redlands Monocline. Photo by R. Cole; Jay Scheevel, pilot. The streak represents glare on the aircraft window.

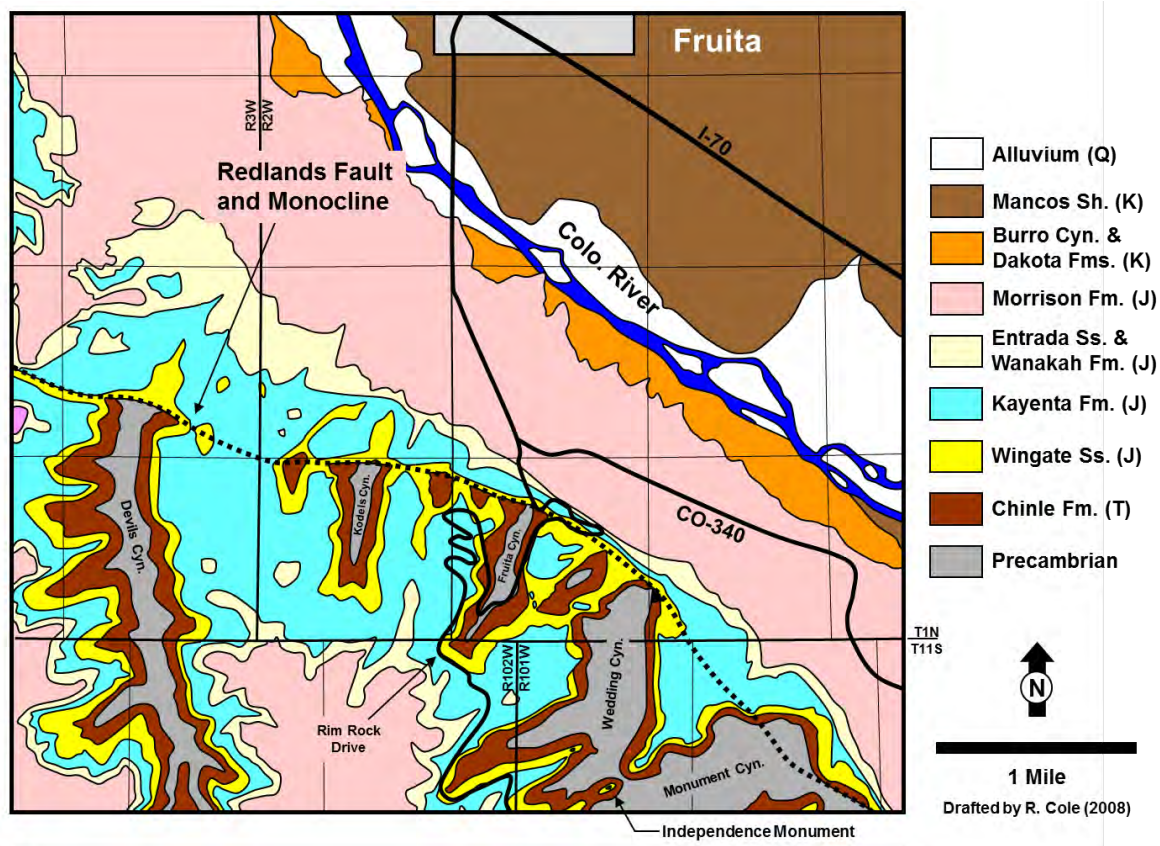
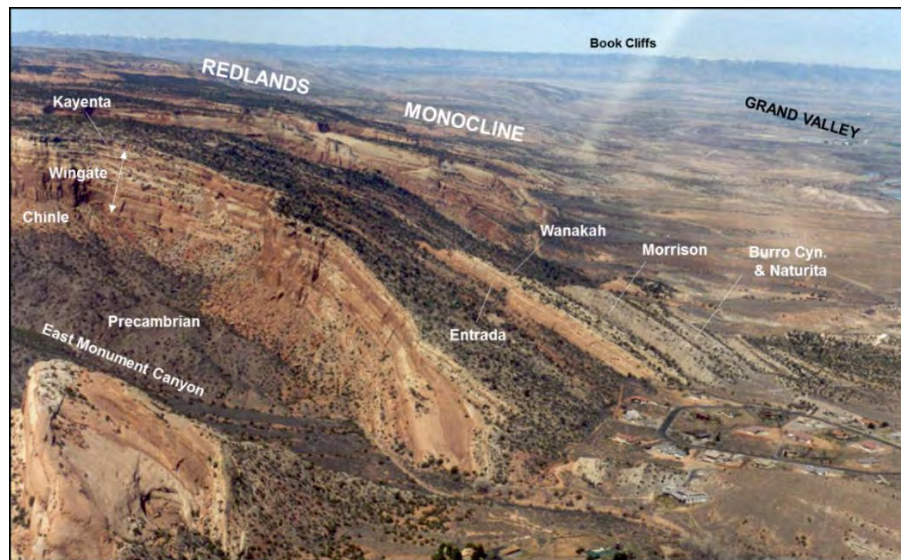


Figure RL1-6. Partial geologic map of Colorado National Monument near Fruita, CO. From **Scott et al. (2001)** and **Cole in Anderson, et al. (2008)**.

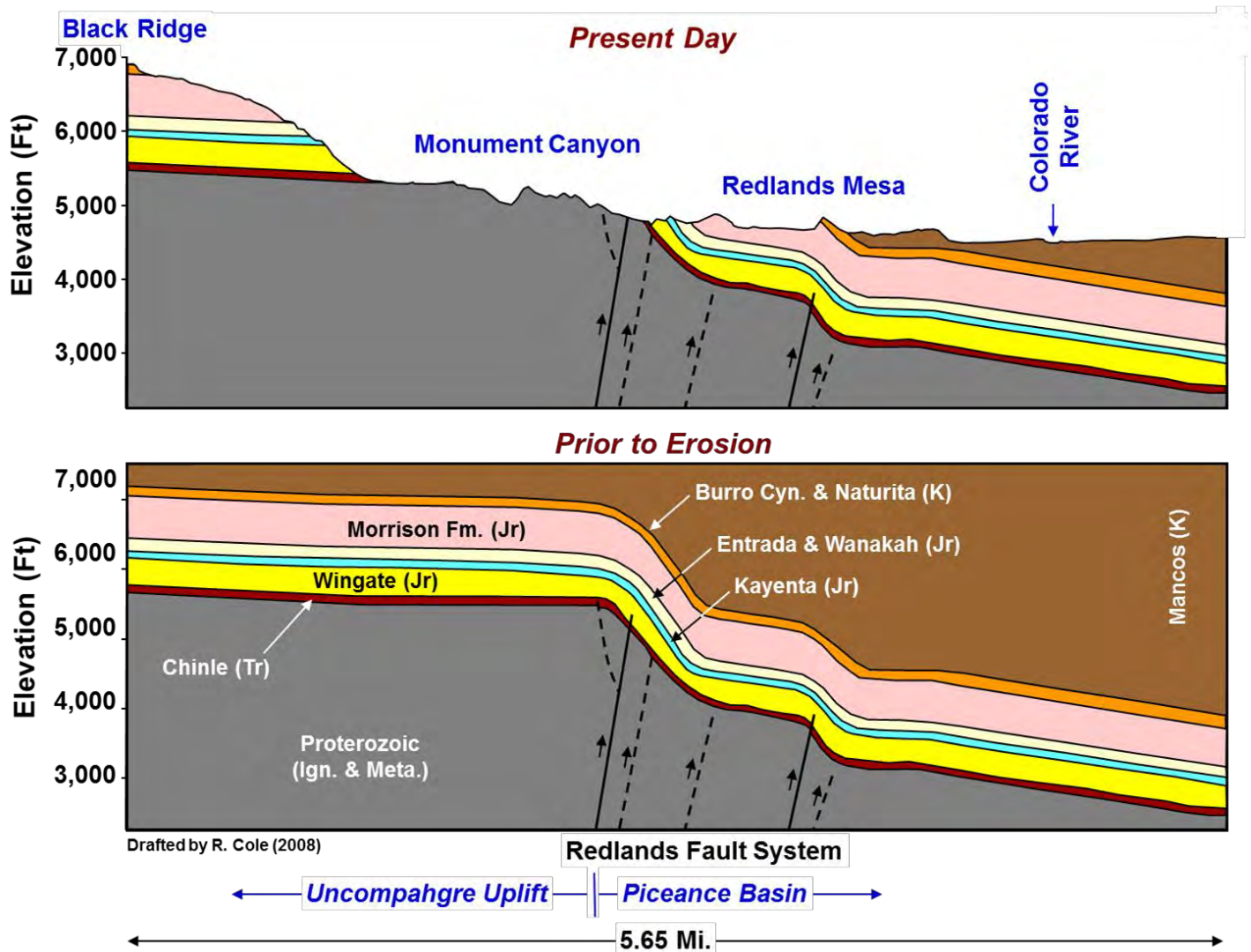
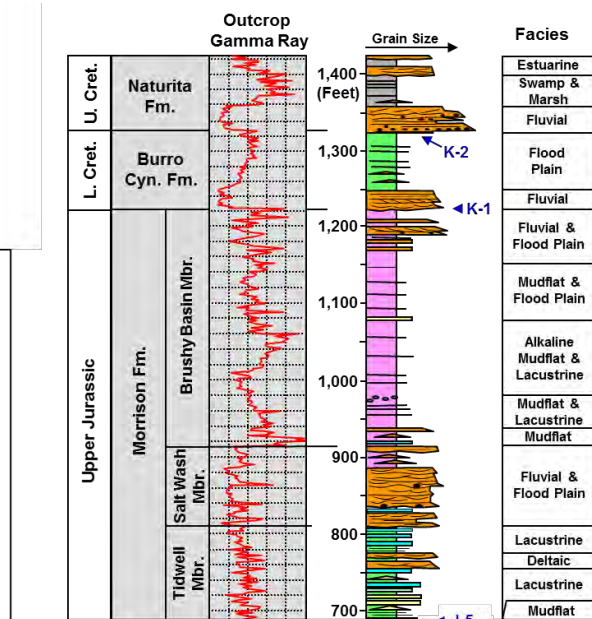
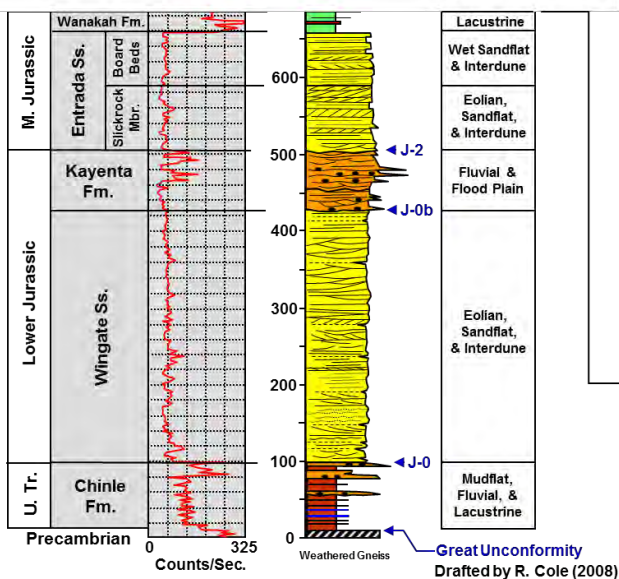


Figure RL1-7. Structural cross section of the boundary between the Uncompahgre Uplift and the Piceance Basin, as defined by the Redlands Monocline and associated fault zone. The faults are high-angle reverse. The lower cross section reconstructs the stratigraphic units forming the monocline and the upper depicts the present-day, after erosion. Sources: **Scott et al. (2001)** and **Cole in Anderson, et al (2008)**.

Part of the focus during the USGS' mapping of Colorado National Monument was on the sedimentological and stratigraphic characteristics of the Triassic-Cretaceous section. Results are presented in **Scott et al. (2001)**, and summarized in **Figure RL1-8**. The total interval is about 1,400 feet thick and consists of eolian (Wingate and Entrada), fluvial/floodplain (Chinle, Kayenta, Salt Wash Mbr. of the Morrison, Burro Canyon, and Naturita), lacustrine (Chinle and Wanakah, and the Tidwell and Brushy Basin Mbrs. of the Morrison), paludal (Naturita Fm.), and lacustrine-deltaic (Tidwell Mbr. of Morrison) depositional systems. Also present are the various unconformities and disconformities (e.g., J-2, K-3) recognized across the Colorado Plateau (see **Figure BG-10**). It is also noteworthy that the Triassic-Jurassic sequence in the Monument is dramatically thicker to the west. This is because of the stratigraphic onlap onto Uncompahgre, which began in Late Triassic time, as discussed in the **Background** information.

Figure RL1-8. Description of the Triassic, Jurassic, and Cretaceous strata present in Colorado National Monument based on field work by R. Cole and W. Hood in support of the USGS' geologic mapping effort (Scott et al., 2001).



Fruita Exit to Mack Exit (~8.4 mi)

After bypassing the Fruita exit, continue west past the Loma Exit (# 15) and the Mack Exit (# 11). **Do not exit at either one.** The Loma Exit sees considerable recreational activity (mountain biking and river excursions), and provides access to CO Hwy. 139, north to Rangely, CO.

Geology

Between Loma and Mack, the route will be close to the Uncompahgre Uplift. The Flume Canyon Monocline now parallels the Interstate for the next 5.3 miles, ending near Salt Creek (about 1.3 miles northwest of the Mack Exit). The topographic feature represented by the fold, is herein called the “Mack-Loma Ridge” (**Figures RL1-9 and RL1-10**). A topographic map is provided in **Figure RL1-11**, and a geologic cross section of the monocline is shown in **Figure RL1-12**.

Figure RL1-9. GoogleEarth image of the Mack-Loma Ridge area along the northwest Uncompahgre Uplift.



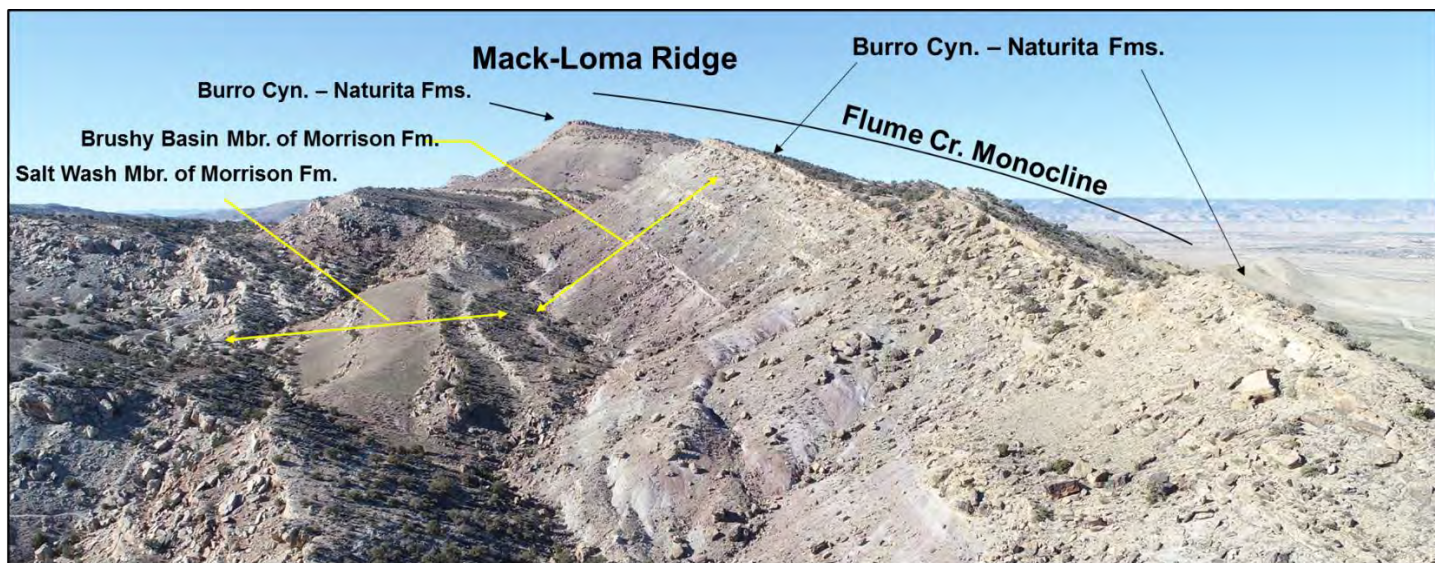
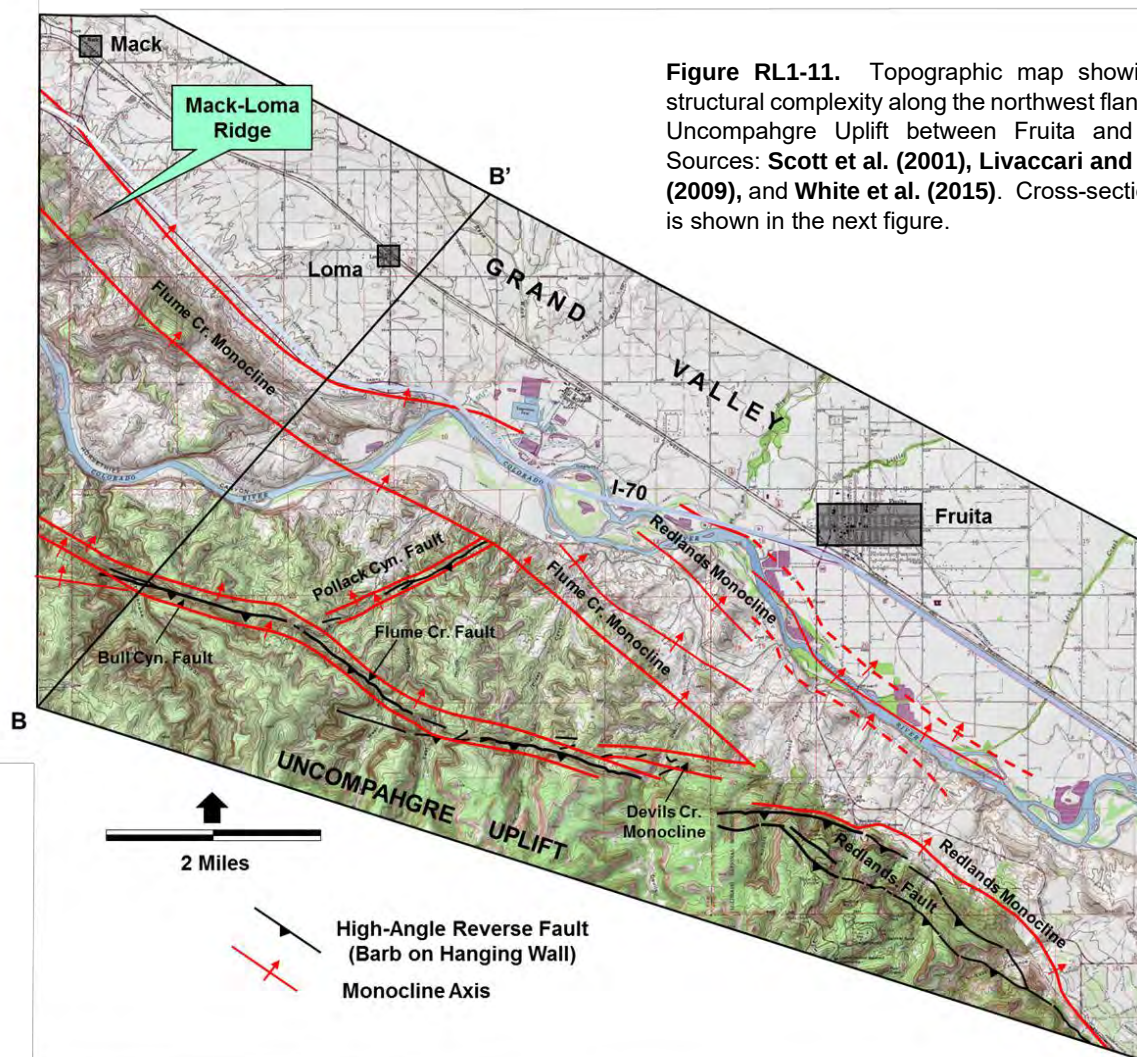


Figure RL1-10 Annotated aerial photo of the southwest flank of Mack-Loma Ridge. The elevation difference from the lower left corner (near the Colorado River) to the ridge line is about 500 feet. Photo by R. Cole.



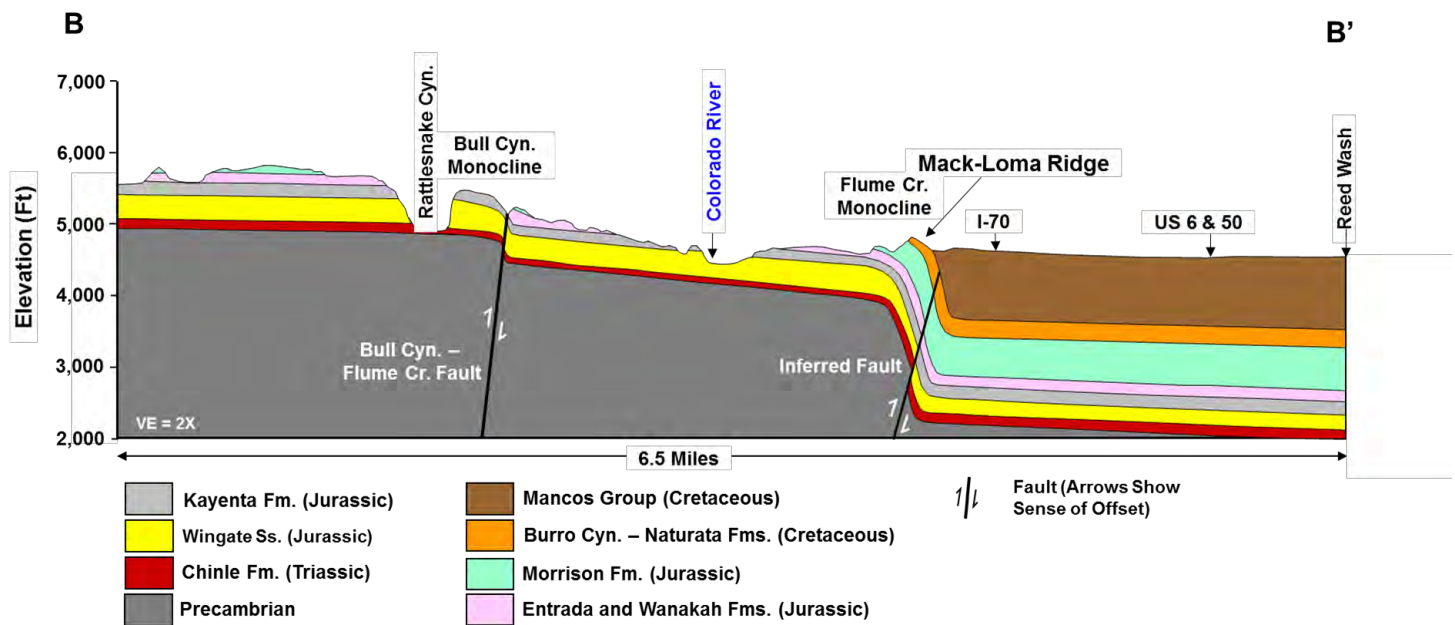


Figure RL1-12 Cross-section B-B' showing the geologic setting of the area between Loma and Mack (see previous figure for location). The Morrison Formation consists of the Tidwell (base), Salt Wash, and Brushy Basin Members. The Mancos Group consists of Tunuck, Blue Hill, Coon Springs, Bridge Creek, and Graneros Members, overlain by the Montezuma Valley and Juana Lopez (Ferron) Members. See **Figure BG-18** for nomenclature. Source: **White et al. (2015)**.

The sedimentological characteristics of the Burro Canyon-Naturita interval have been studied by CMU students (Summer Field Camp) and Javier Tellez (CMU Assoc. Prof. who did part of his dissertation on the Burro Canyon). The results of the student's field work (**Figure RL1-13**) show that the Burro Canyon-Naturita interval ranges in thickness between 250 and 350 feet along the Ridge. Mudrock is the dominant lithofacies, followed by conglomerate, sandstone, and coal. The K-1 regional unconformity separates the Burro Canyon from the underlying Morrison Formation and the K-2 separates the Naturita and Burro Canyon. The Burro Canyon and Naturita will be one of the subjects at **Stop 1** (Harley Dome view area).

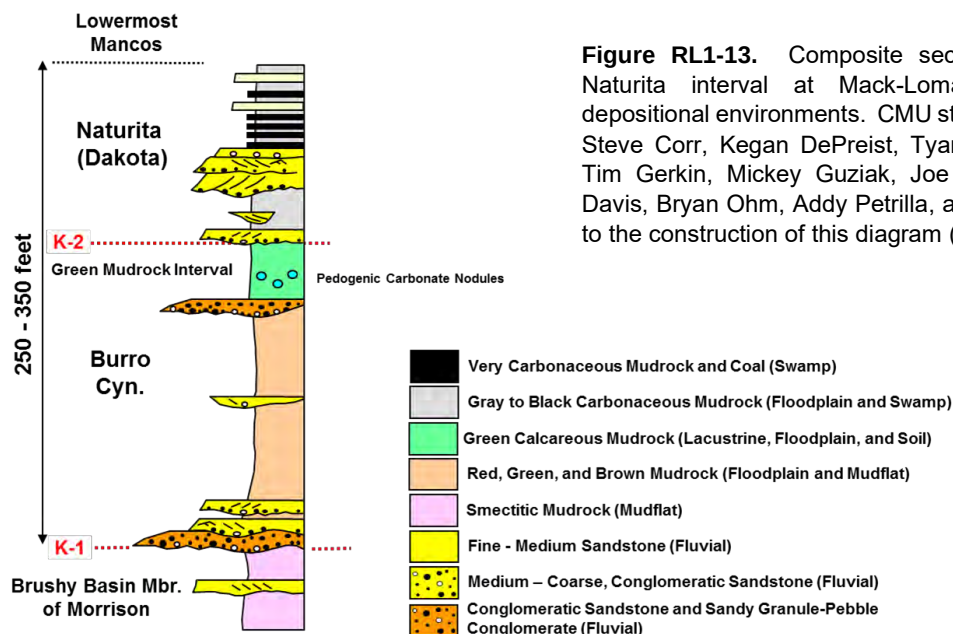


Figure RL1-13. Composite section of the Burro Canyon-Naturita interval at Mack-Loma Ridge with interpreted depositional environments. CMU students Mike Brink, Lilli Clark, Steve Corr, Kegan DePreist, Tyanna Eaton, Robert Gasnick, Tim Gerkin, Mickey Guziak, Joe Mazza, Treyton Nusbaum-Davis, Bryan Ohm, Addy Petrilla, and Lisa Van Kirk contributed to the construction of this diagram (2015).

Mack Exit to Rabbit Valley Exit (~9.4 mi)

After bypassing the Loma Exit, continue west to the Rabbit Valley Exit (# 2), but **do not exit**. The Rabbit Valley area is a popular BLM area for off-road vehicles, hiking, trail riding, and camping (**Figure RL1-14**). This exit also provides access to the BLM's "Trail Through Time" and Mygatt-Moore Dinosaur Quarry. In addition, a BLM road leads south to the Colorado River (Ruby Canyon), following McDonald Creek. It is worth a future excursion (high-clearance, 4X4 recommended).

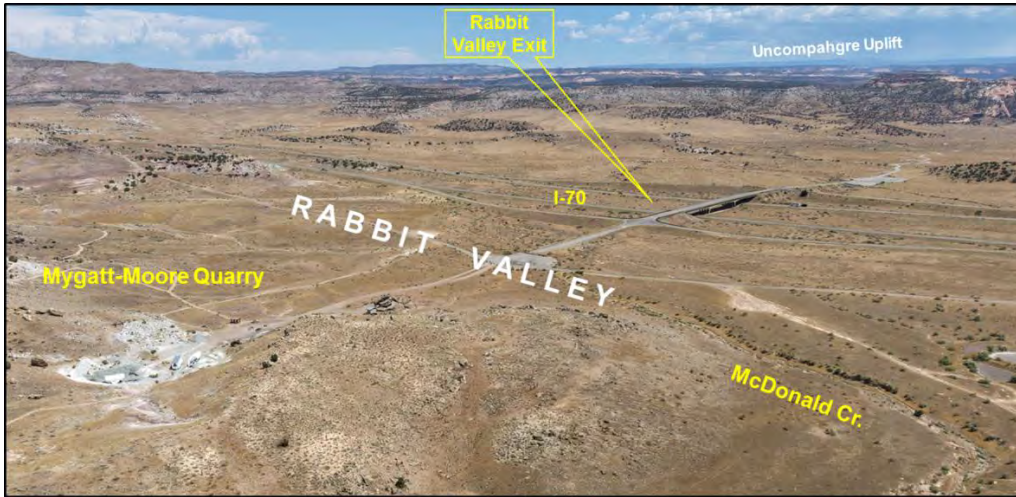


Figure RL1-14. Aerial view of the Rabbit Valley area near the Colorado-Utah line.

Geology

After passing the Mack Exit, I-70 crosses Salt Creek and the railroad tracks, then climbs the shoulder of the Flume Canyon Monocline. Consequently, the road transects the lowermost Mancos, Burro Canyon-Naturita, and into the Brushy Basin and Salt Wash Members of the Morrison. After dissecting the monocline, I-70 enters Rabbit Valley, which is drained by McDonald Wash. The broad expanse of Rabbit Valley is mainly in the Brushy Basin Member of the Morrison. At the exit, the rim to the north is held up by the Burro Canyon/Cedar Mountain and Naturita, which is about 180 feet thick (**Figure RL1-15**). A measured section is provided in **Figure RL1-16**.

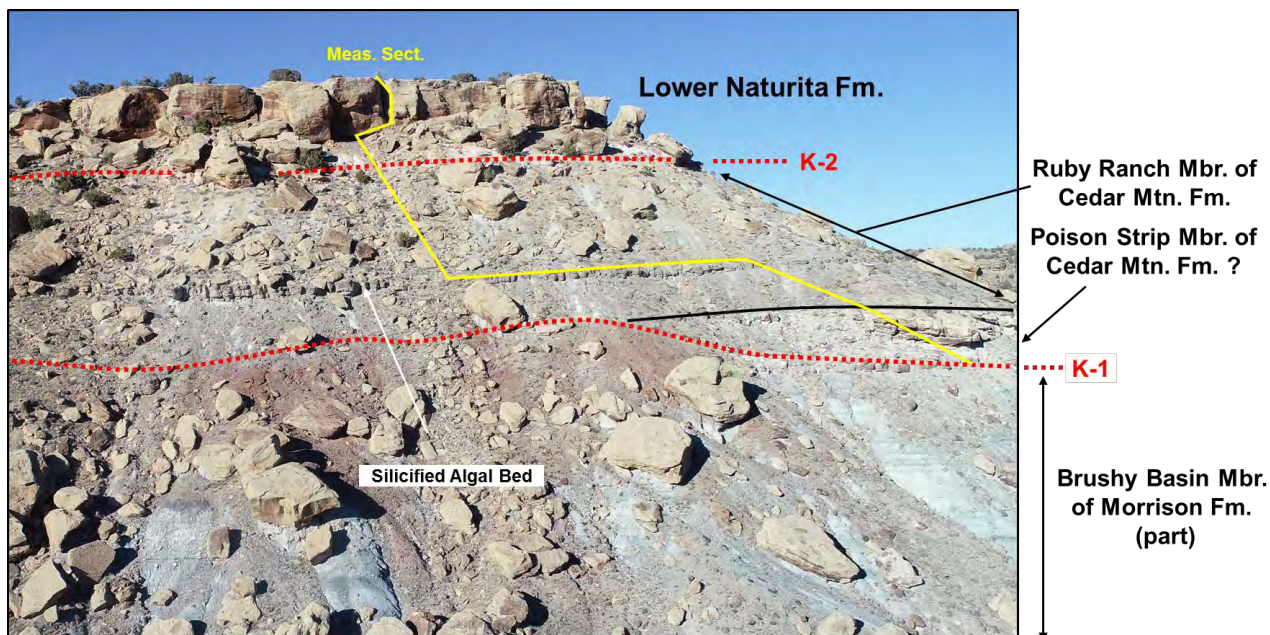


Figure RL1-15. Photo of the rim that outlines Rabbit Valley. The cap rock is represented by a sequence of fluvial sandstone, carbonaceous mudrock and coal in the Naturita Formation. The measured section is provided in the next figure. Note that since this location is near the State Line, Utah terminology is used. The Naturita remains the same; however, the Burro Canyon is now called the Cedar Mountain, and is subdivided into two members: Poison Strip and Ruby Ranch. The K-1 and K2 are regional unconformities.

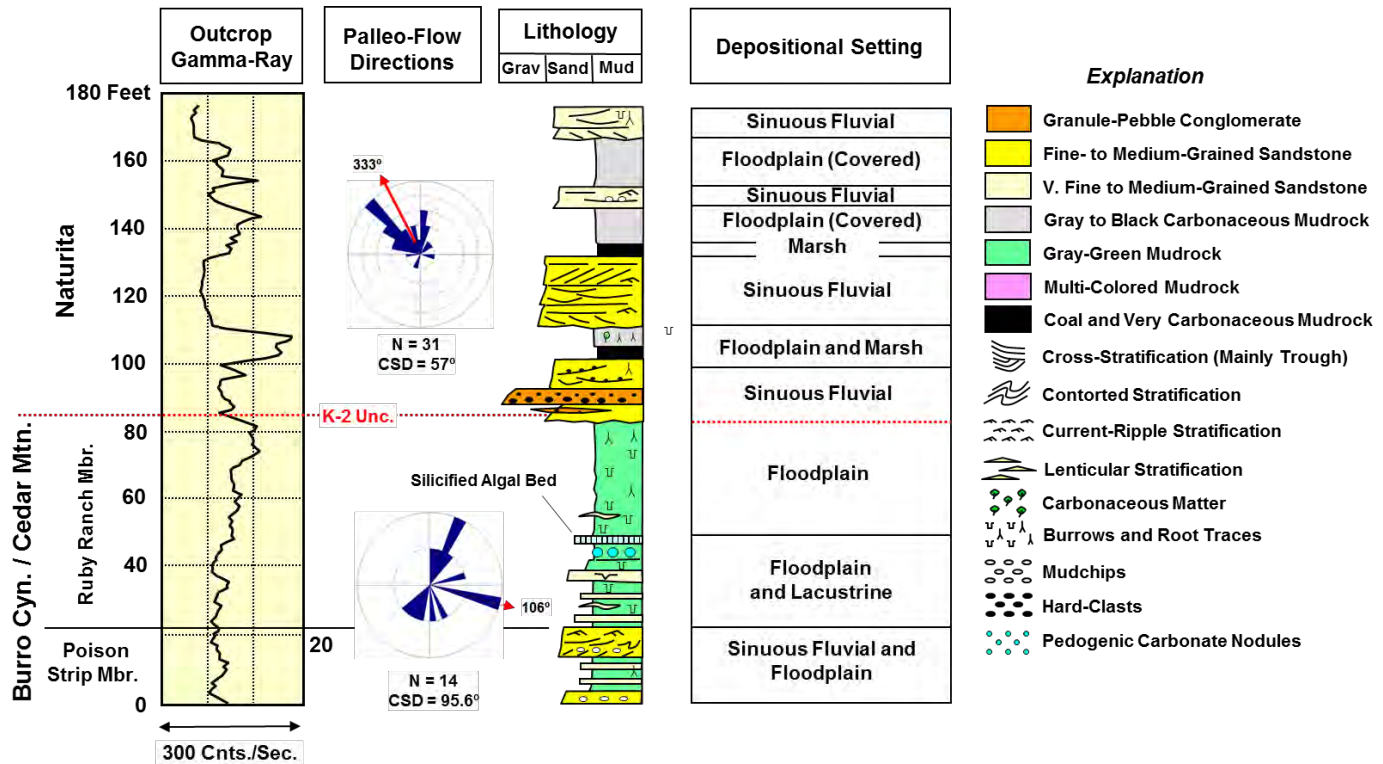


Figure RL1-16. Measured section of the Cedar Mountain-Naturita interval at Rabbit Valley. Source: **Cole and Moore (2012)**.

From the Rabbit Valley overpass, a large fold is visible about 1.5 miles to the south (**Figure RL1-17**). It has several names including the Black Rocks Monocline (**Heyman, 1983**) and the McDonald Creek Anticline. The structure is associated with the Bull Canyon Fault. The thick sandstone that forms the crest of the structure is the Entrada Sandstone.



Figure RL1-17. Aerial views of the Black Rock Monocline (McDonald Cr. Anticline) south of the Rabbit Valley Exit. The stratigraphic sequence is very similar to what is in Colorado National Monument.

Rabbit Valley is well known for the numerous paleontological discoveries, mainly dinosaurs. The Mygatt-Moore Quarry is visible to the north from the Rabbit Valley Exit. It is on BLM land, with support of the Museums of Western Colorado, who maintain the Quarry and provide valuable public insight and education. Excavations began in about 1982 (**Armstrong et al., 1987**) in the Brushy Basin Member of the Morrison. The initial fossil discoveries were made by Peter and Marilyn Mygatt and J.D. and Vanetta Moore. Fossils include sauropods (*Diplodocus*, *Camarasaurus*, and *Apatosaurus*), armored dinosaurs (e.g., *Mymoorapelta*), and Therapods, such as *Allosaurus*. Plant fossils, include carbonized wood and cycads. Other fossils include amphibians, reptiles, fish, spores, and pollen (source: **BLM website**). Most specimens in the quarry are encased in mudrock. The Trail Through Time (~1.6 mi), which begins near the quarry, has dinosaur vertebrae exposed in sandstone. Some specimens are on exhibit at the Dinosaur Journey Museum in Fruita. The trail is a worthwhile future excursion.

Rabbit Valley Exit to Stop 1 at the Harley Dome View Site (~5.4 mi)

Once bypassing the Rabbit Valley Exit, I-70 crosses the Colorado-Utah State Line and continues west approximately 3.5 miles to the exit for the Harley Dome View Area. **Take this exit** and park in the large lot. If needed, odiferous outhouses are available. For the discussion, we will possibly ascend (~50 ft) along a paved path (~550 ft) to a shelter on the small knob (**Figure RL1-18**). Please see **Stop 1** in the **Field Stops pdf**.



Figure RL1-18. Photo showing the paved path to the possible discussion location for **Stop 1**. Photo by R. Cole.

Geology

After the Rabbit Valley Exit, I-70 climbs up the northeast flank of the Black Rocks Monocline and cuts through the Brushy Basin Member of Morrison, the Cedar Mountain-Naturita interval, and into the lower Mancos Shale (Tununk Shale). Then it descends into an unnamed syncline near the Utah-Colorado boundary, followed by a gradual ascent of the northeast flank of the Bitter Creek Anticline and back into the Cedar Mountain-Naturita. At the state line, rounded sandstone concretions in the Coon Springs Sandstone of the Mancos Group are conspicuous north of the highway. They are discussed at **Stop 1**.

Harley Dome View Site to the Sulphur Exit (# 221) (~6.3 mi)

After rejoining I-70 and driving about 0.6 miles, the highway intersects the Westwater Exit (#227). **Do not exit.** North of Exit 227 are a number of buildings related to pipeline operations and an inactive helium processing facility (see discussion for **Stop 1**). Harley Dome was originally related to sheep and cattle ranching. Departing from the south side of the exit, BLM Road 192 leads to the Westwater Ranger Station and boat launch (~8.5 mi). To the north, a short road leads to old US 6 & 50. [Note -- You can return to Mack on this sparsely maintained highway.]

Approximately 4.3 miles west of the Westwater Exit (#227) overpass, I-70 crosses Westwater Creek, which is a major ephemeral drainage from the Book Cliffs. Continuing west from the creek is the Sulphur Exit (#221). **Do not exit.**

Geology

After rejoining I-70, the route descends the southwest flank of the Bitter Creek Anticline into the Bryson Wash Syncline, then across the Harley Dome Anticline. The structures plunge to the northwest. Excellent outcrops of the Morrison-Cedar Mountain-Naturita-lower Mancos interval (**Figure RL1-19**) are present between the Westwater Exit and the BLM Westwater Ranger Station (via Road 191). It is worth visiting at a later time.

The Cedar Mesa is thin and dominated by mudrock (Ruby Ranch Mbr. ?); however, the Naturita consists of a series of high-energy fluvial sandstones and conglomerates; thin coals and carbonaceous mudrock are also present (**Figure RL1-20**). The Naturita is transitional upward into the lower Tununk Shale. A partial measured section of the Naturita is shown below (**Figure RL1-21**).

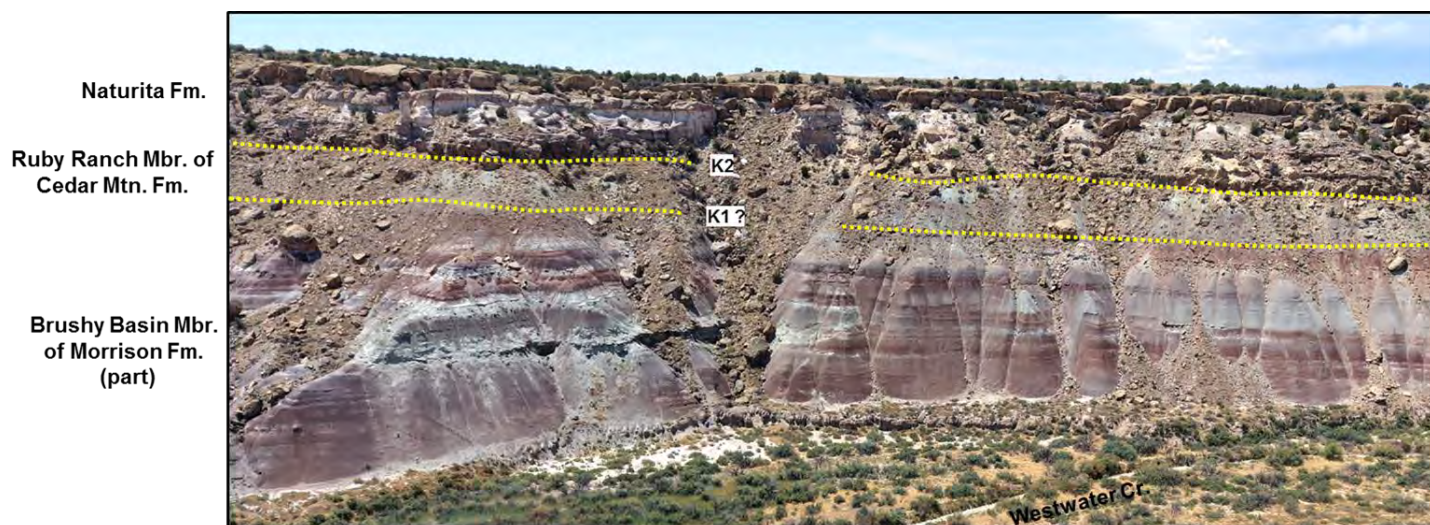


Figure RL1-19. Aerial photo of the Brushy Basin, Cedar Mountain (Ruby Ranch Mbr.), and lower Naturita Fm. on the west side of Westwater Creek, about 2.7 mi southeast of I-70. Note that the Ruby Ranch – Brushy Basin contact is based on a color change from red (BB Mbr.) and light green (RR Mbr.), and the presence of pedogenic carbonate nodules in the Ruby Ranch. The lowest Naturita interval (brown) is an impressive sandy conglomerate. The white bed is a sandstone has been bleached by descending acidic swamp water from a thin coal interval above it (a Cretaceous event). The uppermost brown bed is a fluvial conglomeratic sandstone. Photo by R. Cole.

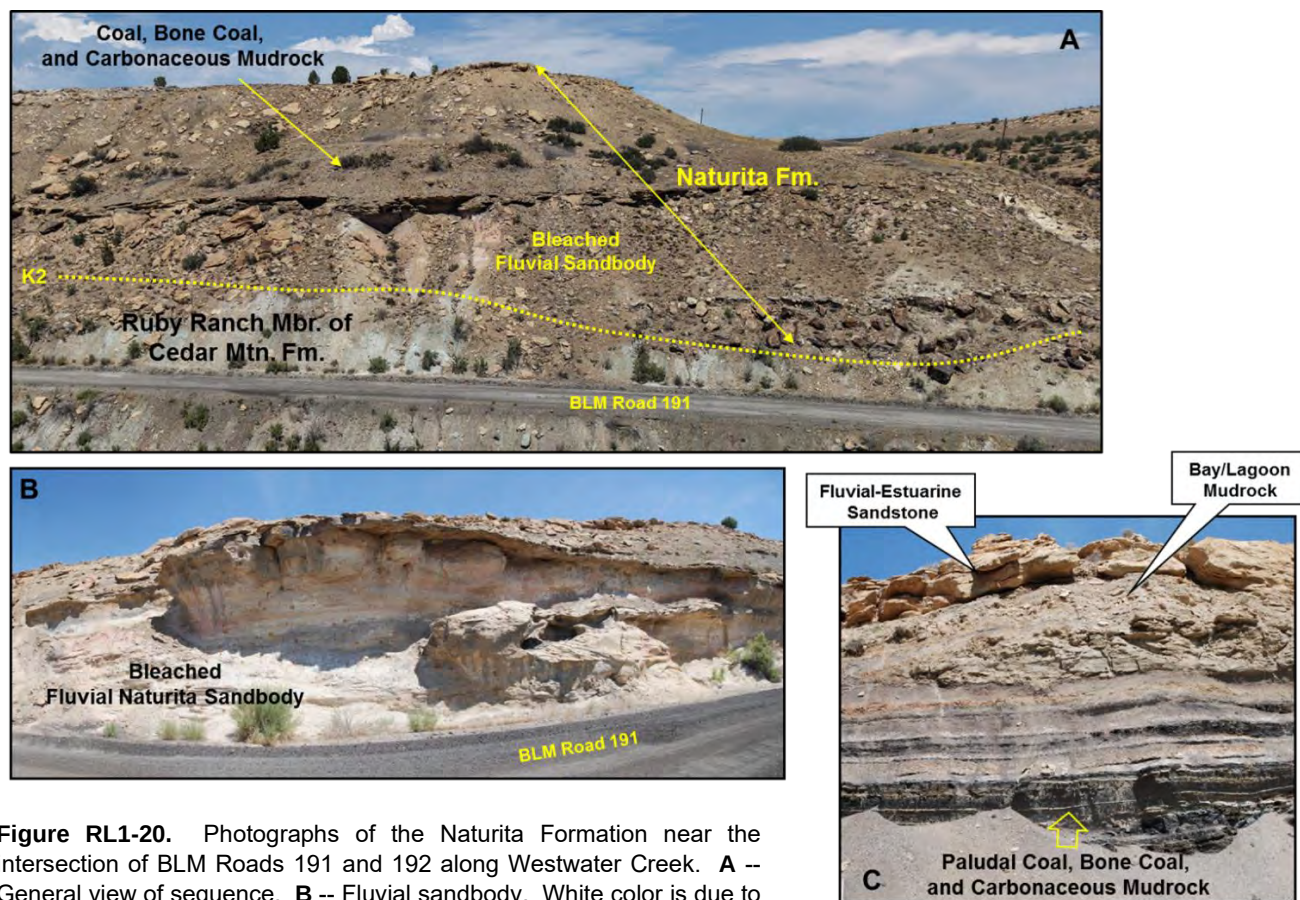


Figure RL1-20. Photographs of the Naturita Formation near the intersection of BLM Roads 191 and 192 along Westwater Creek. **A** -- General view of sequence. **B** -- Fluvial sandbody. White color is due to organic acids from overlying carbonaceous rocks. **C** -- Coal and carbonaceous mudrock. The **Anderson and Harris (2006)** measured section started here (see next Figure).

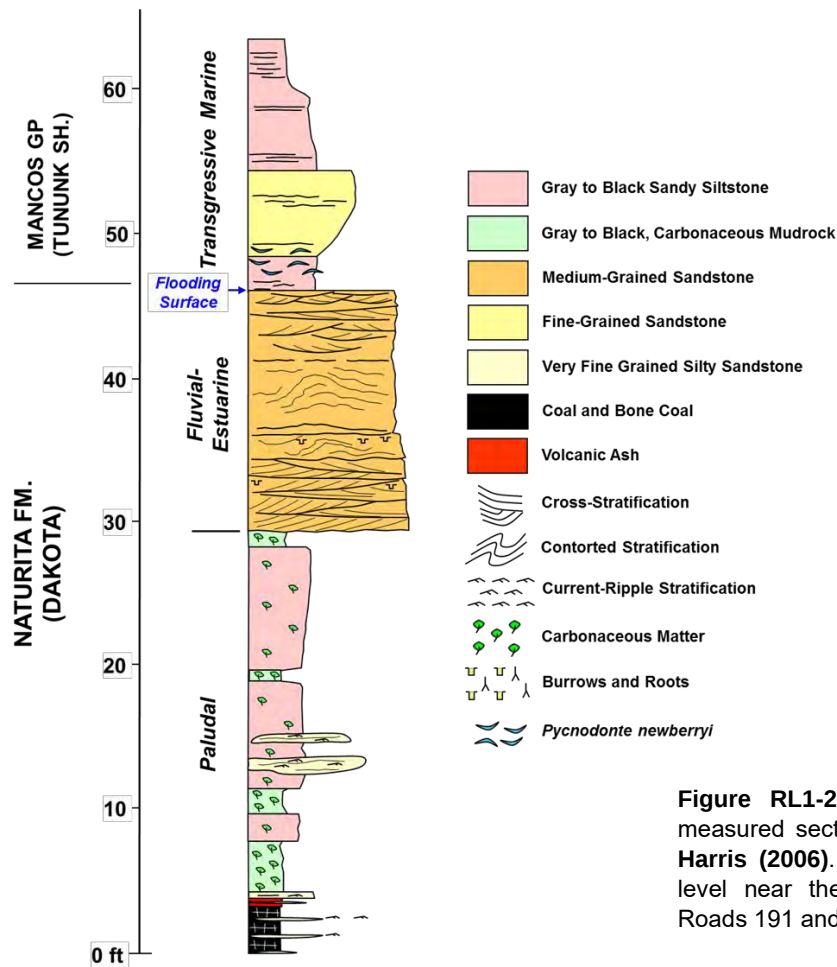


Figure RL1-21. Partial Naturita measured section by **Anderson and Harris (2006)**. The base is at road level near the intersection of BLM Roads 191 and 192.

At the I-70 overpass over Westwater Creek, there are good exposures of the upper Juana Lopez Member of the Mancos Group (**Figure RL1-22**). The outcrop consists of dark-gray to black, organic-rich, fissile to papery, laminated silty claystone, with three conspicuous bentonite beds (**Figure RL1-22C**). This interval is a major source rock for oil and gas in the southern Uinta Basin.

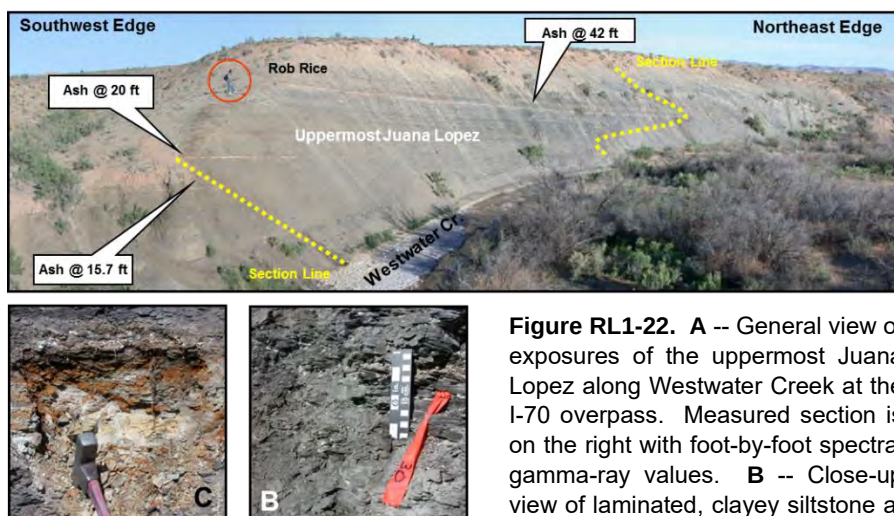
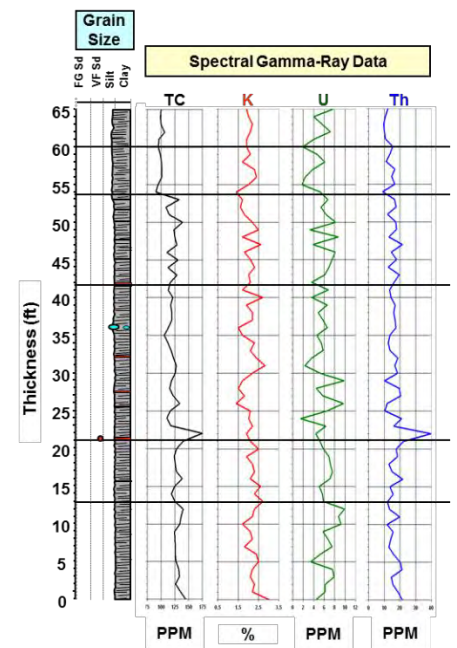
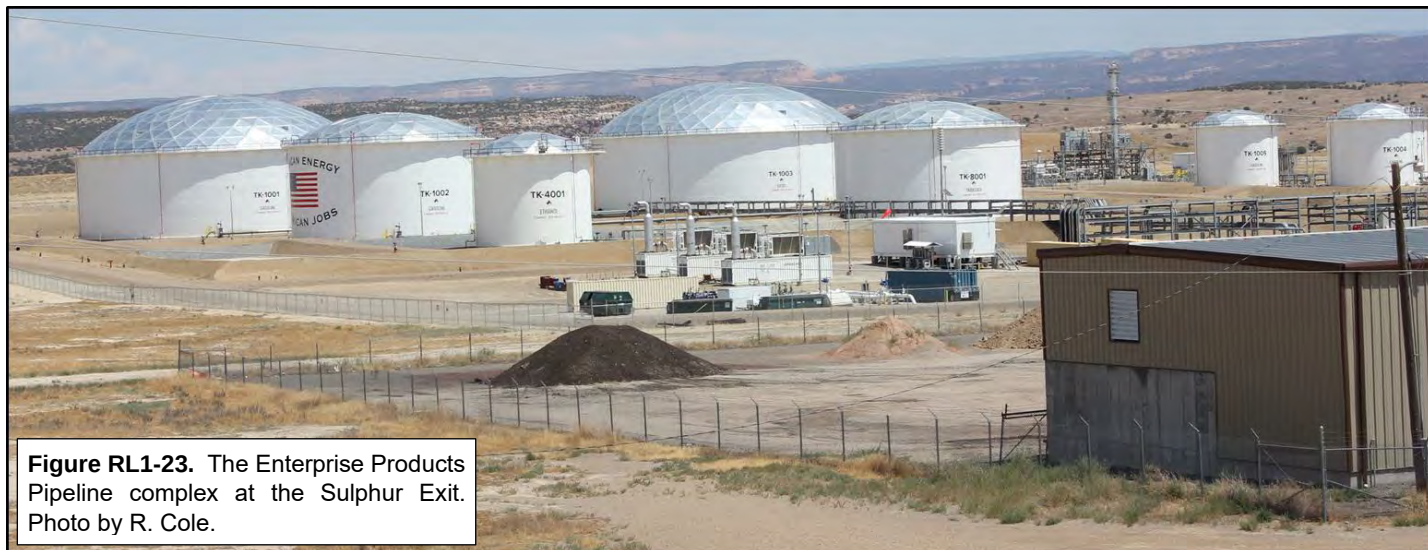


Figure RL1-22. A -- General view of exposures of the uppermost Juana Lopez along Westwater Creek at the I-70 overpass. Measured section is on the right with foot-by-foot spectral gamma-ray values. B -- Close-up view of laminated, clayey siltstone at 30 feet on section. C -- Close-up view of bentonite at 20 feet.



The Sulphur Exit (#221) from I-70 is about 0.9 miles southwest of the overpass over Westwater Creek. The Westwater Road connects to this interchange after passing under the overpass. Here, a large industrial site is visible just south of the highway (**Figure RL1-23**). It is a refined products terminal owned and operated by Enterprise Products Pipelines as part of their Texas Western Products system. It was put into service in October, 2024, to serve Grand Junction, Moab, and nearby areas. The products stored and sold here originated in refineries at Beaumont and Baytown, TX. From there they were transported to Mont Belvieu, TX, a city about 30 miles east of Houston, where they were stored prior to being put into the pipeline for transport to EPP's various terminals in West Texas, New Mexico, and here. The stored products include unfinished regular and premium-grade gasoline, ultra-low-sulfur diesel, ultra-low-sulfur heating oil, ethanol, and transmix (impure products that got mixed with other products during transportation). Unfinished gasoline refers to gasoline that does not meet EPA requirements. Ethanol is added at the facility to meet the EPA requirements. The facility can store 400,000 barrels of gasoline, diesel, and heating oil and can load up to 20,000 barrels per day through its three truck bays (summary by Bill Hood).



Sulphur Exit (# 221) to Danish Flat Exit (#214) (~7. mi)

There are no exits on I-70 between the Sulphur Exit and the Danish Flat Exit (#214). **Please take the Danish Flat exit**, then follow the BLM road to **Stop 2** (follow lead vehicle). **Stop 2** is about 6.5 miles down the BLM road.

For reference, the Danish Flat exit also provides bumpy access to Cisco, UT, via old US Highway 6 & 50. Return to I-70 after **Stop 2**.

Geology

See **Stop 2**.

Danish Flat Exit to Utah Welcome Center and Stop 3 (~24.7 mi)

After the Danish Flat Exit, I-70 passes the Cisco Exit (#204) and the Yellow Cat Exit (#193). The Welcome Center is at Mile Marker 190. **Please take the exit**. After parking we will possibly take a good path about 450 feet to an observation kiosk where the Stop 3 discussion will take place. Alternatively, the discussion may be in the parking area.

The Cisco Exit provides access to UT-128, which leads to Dewey Bridge, Professor Valley (Fischer Towers), and Moab. A road north into the Book Cliffs can also be accessed from the Cisco Exit. Called the Windy Mesa Road (also Grand County Road 170), it leads to the Cisco Dome oil-and-gas field (**Figure BG-23**), the old Cunningham Ranch, and scenic Nash Wash. The Yellow Cat Road provides access to numerous old uranium mines in the Morrison Formation, and interesting outcrops of the Cedar Mountain Formation (discussed at **Stop 5**).

Geology

The route from the Danish Flat Exit to **Stop 3** is pretty much devoid of interesting surficial geologic features. Basically, it consists of desert prairie underlain by the Mancos Shale. Because the route gradually moves towards the Book Cliffs, higher members and intervals of the Mancos Group are transected (**Figure BG-17**). At Westwater Creek, I-70 rested on the Juana Lopez, while at the Welcome Center, it is in the upper Prairie Canyon Member. Thus, I-70 has ascended stratigraphically about 2,000 feet, mostly through the lower Blue Gate Shale. From a structural perspective, the route crosses the Cottonwood Creek Anticline, Cisco Springs Anticline, Cisco Anticline, and Sagers Wash Syncline (**Figure RL1-2**). The anticlines host the Sieber Nose, Danish Wash, Sage, Cisco Springs, Cisco Wash, and Cisco Dome oil and gas fields (**Figure BG-23**). Production is from the Entrada, Morrison, Cedar Mountain, Naturita, and lower Mancos.

See also the text and figures for **Stop 3**.

Utah Welcome Center to Floy Exit (14.1 mi)

Approximately 2.2 miles from the Welcome Center, is the Thompson Springs Exit (#187), which leads to Thompson and access to Thompson and Sego Canyons. **Do not exit.** Next, after another 5.3 miles, is the Crescent Junction Exit and the intersection with US Highway 191 (road to Moab) **Do not exit.** Continuing west beyond Crescent Junction, the next exit (6.6 mi) is at Floy (#175). **Take this exit and turn left (south) on the Ruby Ranch Road.** **Stop 4** is about 0.5 miles south of the Ruby Ranch Road/I-70 overpass. **Road log 2** begins at this location.

Geology

The route from the Welcome Center to the Floy Exit continues to be on the upper Mancos. Several boring road cuts are intersected. Because I-70 is near the Book Cliffs, flights of Pleistocene, gravel-capped terraces are present. Some terraces are related to pediment development, whereas others represent Pleistocene outwash from drainages exiting the Book Cliffs (e.g., Floy Wash and Thompson Creek). The resistant nature of the thin (<30 ft) gravel caps has created topographic reversals as the Mancos was eroded from around the gravel. The highest terrace near Crescent Junction is about 130 feet high. [Note – a UDOT rest area for eastbound I-70 is on this terrace. Something to consider on the return trip.]

Approximately 0.8 miles north of Crescent Junction is a large Uranium Mill Tailings Radiation-Control Act (UMTRA) disposal site (**Figure RL1-24**) for uranium mill tailings from the former mill in Moab. The Uranium Reduction Company operated the Moab mill from 1956 until 1962 when it was sold to Atlas Minerals Corporation. Milling operations ceased in 1984. Tailings are transported mainly by rail. The disposal site, which is approximately 230 acres, sits on the Prairie Canyon Member and upper Blue Gate Shale (**Figure RL1-25**). Construction of the site began in 2008 (**Document DOE-EM/GJRAC1547, 2024**). Craig Goodknight was the lead geologist who worked on this site (see **Goodknight et al., 2008**, and **Moab UMTRA Project Final RAP and Site Design, Revision 3, May 2024; DOE-EM/GJRAC1547**).



Figure RL1-24. Aerial view of the UMTRA site near Crescent Junction, UT.

Source:

<https://www.energy.gov/em/articles/moab-disposal-cell-progress-continues-new-interim-cover-installation>

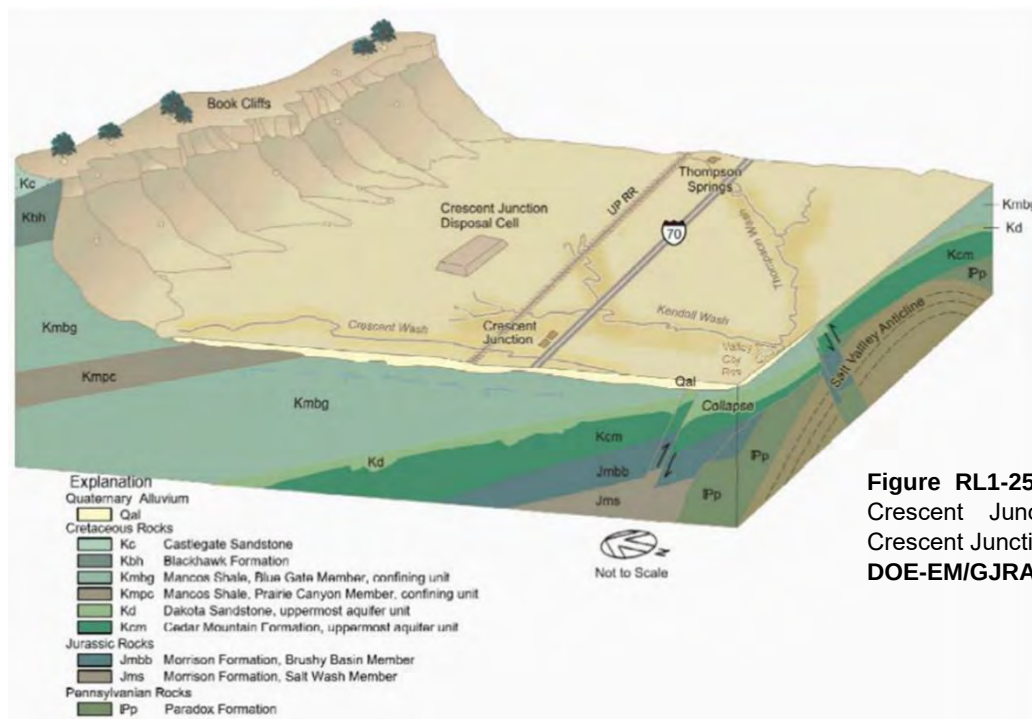


Figure RL1-25. Schematic view of the Crescent Junction UMTRA site near Crescent Junction, UT. Source: DOE Doc. DOE-EM/GJRAC1547, 2024.

End of Road Log 1

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