GEOLOGY OF COLORADO NATIONAL MONUMENT

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Introduction

[1] Colorado National Monument is a land of towering red sandstone monoliths and deep sheer-walled canyons. It is located on the Colorado Plateau at the northeastern edge of the Uncompahgre Plateau. The park is characterized by an excellent example of a monocline, a sequence of Mesozoic strata and it is one of the few places on the Colorado Plateau where we can observe the Precambrian basement rocks (figures 1 & 2).

Geology & Stratigraphy

An impressive monocline defines the eastern margin of the Uncompahgre Plateau. A monocline is a "one-sided fold" (figures 3 and 4). Uplift and formation of the monocline most likely occurred during the Laramide Orogeny when Precambrian basement faults were reactivated. As uplift occurred along these faults the overlying sedimentary strata were slowly bent to conform to the new shape of the basement rocks. Uplift of the Uncompahgre Plateau brought Precambrian schist, gneiss and granite close to the earth's surface and subsequent erosion has resulted in exposing these units at the base of the canyons.

The Triassic Chinle Formation overlies the Precambrian basement, and forms dark red slopes of hematite-pigmented shales and siltstone. The age of the rock units overlying basement varies across Colorado; in Golden these rocks are Pennsylvanian and at Dinosaur National Monument they are Precambrian in age. The hiatus represented by this disconformity is greatest (represents the longest period of time) in the Colorado National Monument area, indicating that this region was a structural high. Uplift occurred during the Pennsylvanian, forming a series of mountain ranges known collectively as the Ancestral Rocky Mountains. One of these ranges occurred in this area and is known as the Uncompahgre Highlands. Following uplift erosion stripped away the lower Paleozoic units and these ancient mountains were eventually worn down to a level plain. The mountains did not occur in the area around Dinosaur National Monument so we can still observe the older sedimentary units in that area. The newly formed mountains were the source area for the Fountain Formation that we observed in the Golden area. The Uncompahgre Highlands remained a positive area until the Triassic when it was covered by sediments. It was not until the early Cenozoic that it was once again uplifted to form a positive area that we now call the Uncompahgre Plateau.

The dramatic scenery at Colorado National Monument, including the vertical cliffs and monoliths are composed of the Triassic Wingate Sandstone which is overlain by the resistant, silica-cemented Kayenta Formation. These units are part of the Glen Canyon Group which consist of the Wingate Sandstone, Kayenta Formation and Navajo Sandstone. The Navajo Sandstone and upper part of the Kayenta Formation were eroded away from this area. The Glen Canyon Group represents two periods of eolian deposition (Wingate and

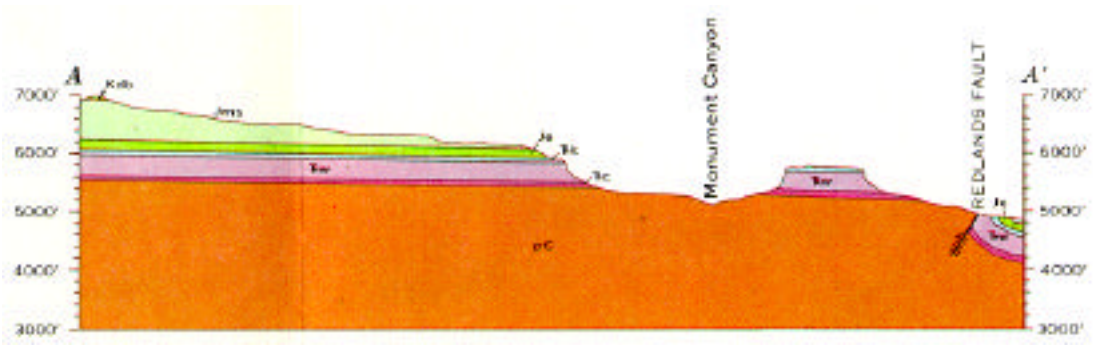

Figure 4. Geologic cross-section of Colorado National Monument (Lohman, 1963).

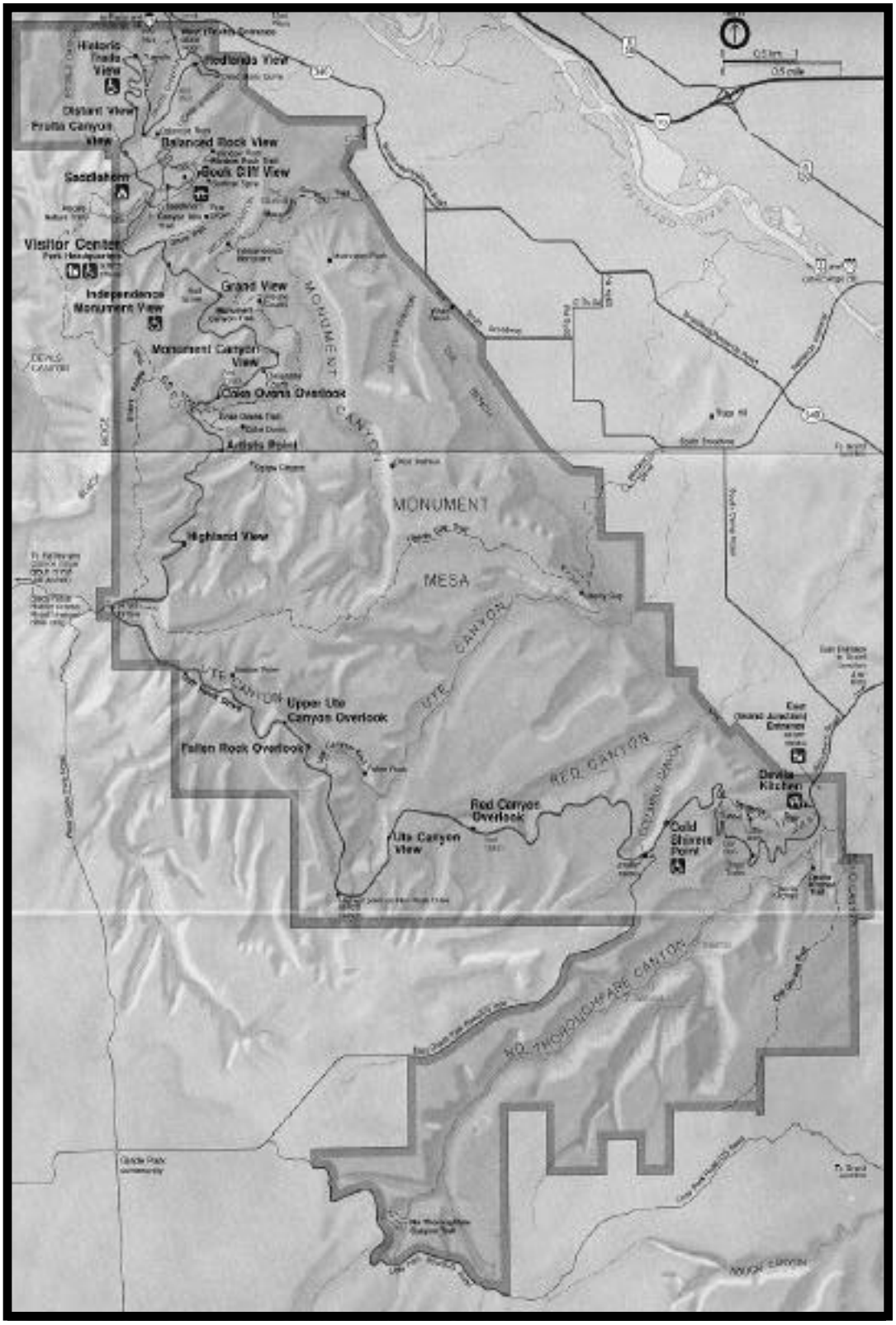

Figure 1. Map of Colorado National Monument (National Park service).

Age	Thick. (ft.)		Description
Quaternary	**variable**	**Qal**	**Alluvium** Silt, sand and gravel, upper Pleistocene and recent valley or canyon fill.
	variable	**Qls**	**Landslide deposits**
	variable	**Qtg**	**Terrace gravel**
Cretaceous	**3,800**	**Km**	**Mancos Shale** Gray marine shale with thin beds of sandstone near the base and thin beds of limestone.
Cretaceous	150	**Kdb**	**Dakota Sandstone** Coarse white basal conglomerate, lignitic shale, buff sandstone and thin beds of lignite.
	Unconformity		
Cretaceous	60	**Kdb**	**Burro Canyon Formation** Sandstone, conglomeratic sandstone, conglomerate and green-hued shale.
Jurassic			**San Rafael Group**
	600	**Jms**	**Morrison Formation** Varicolored siltstone and mudstone, bentonitic beds, volcanic ash, thin beds or lenses of white to brown sandstone and limestone. **Brushy Basin Member** at the top contains beds of conglomerate. **Salt Wash Member** at the middle contains siltstones and mudstones, thick lenticular sandstone and thin beds of gray limestone.
	54	**Jms**	**Summerville Formation** Varicolored mudstone and siltstone. Persistent thin beds of varicolored, hard sandstone at the base.
	150	**Je**	**Entrada Sandstone** White to gray evenly bedded fine grained sandstone at the top. Salmon colored to pink fine-grained cross-bedded sandstone at the base.
	Unconformity		
Triassic			**Glen Canyon Group**
	45-80	**Trk**	**Kayenta Formation** Medium to coarse-grained highly lenticular sandstone with red or purple siltstone and mudstone, and lenses of conglomerate and conglomeratic sandstone.
	350	**Trw**	**Wingate Sandstone** Thick beds of salmon colored to buff, cross-bedded, fine-grained sandstone.
Triassic	**80-100**	**Trc**	**Chinle Formation** Red siltstone containing thin lenses of green limestone or limestone conglomerate.
	Unconformity		
Precambrian		**pC**	Schist, gneiss, granite and pegmatite

Figure 2. Description of stratigraphic units at Colorado National Monument (modified from Lohman, 1963).

Navajo) separated by a period of more humid fluvial deposition (Kayenta). During Wingate and Navajo time, the western United States was covered by a large sand sea, known as an erg. The term erg is used in the Sahara for a vast region covered deeply with pure sand and occupied by dunes. The Wingate and Navajo Sandstones are classic examples of eolian deposits or wind blown sand dunes. The feature most characteristic of eolian deposits is their enormous cross-beds (figure 5). Cross-beds form when dunes migrate. Sand is transported up the gentle stoss slope of the dune and cascades down the steeper lee slope forming foreset cross-beds. Cross-beds can form both subaerially by migrating sand dunes

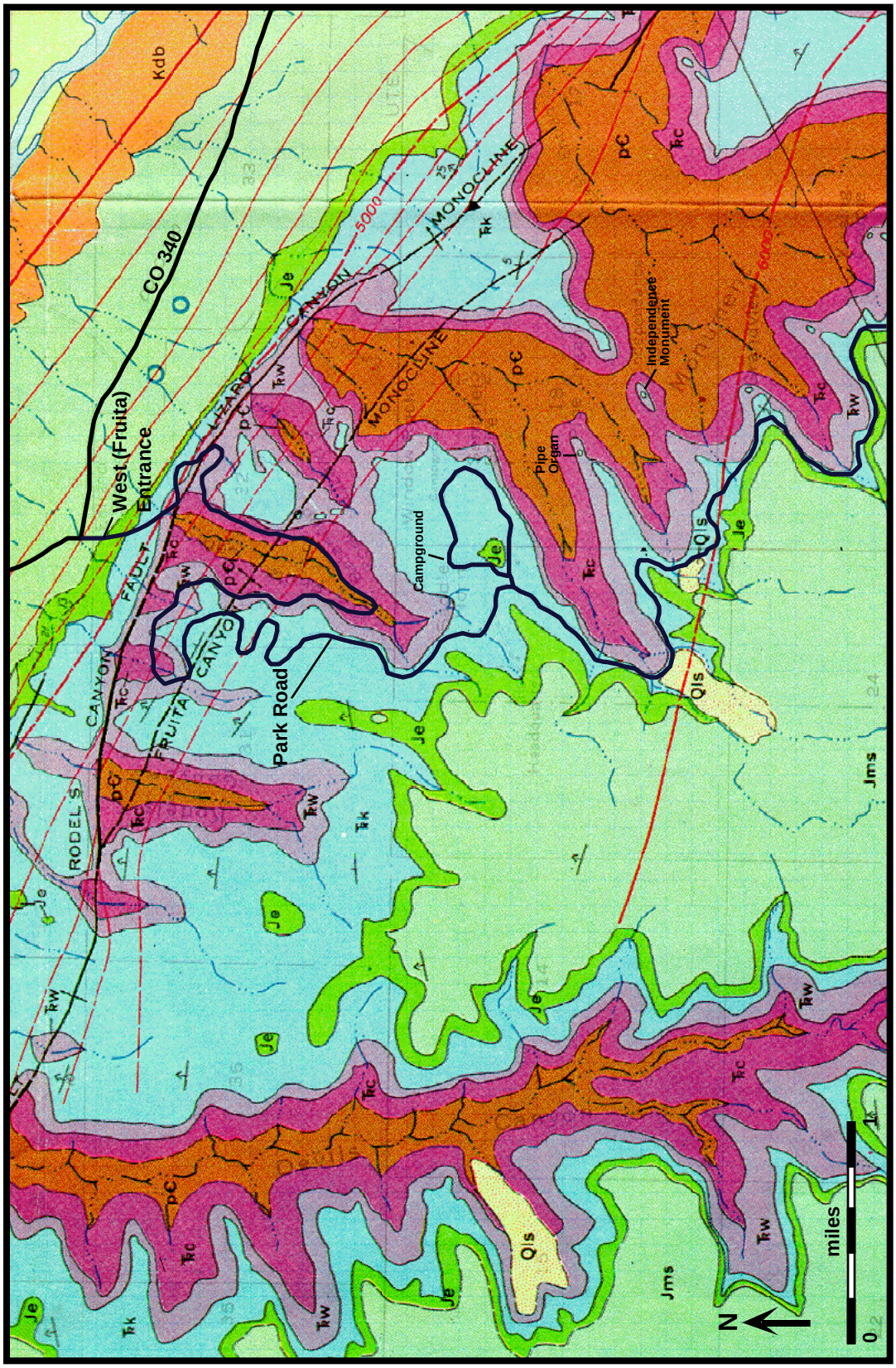

Figure 3. Geologic map of the west entrance area, Colorado National Monument (Lohman, 1963).

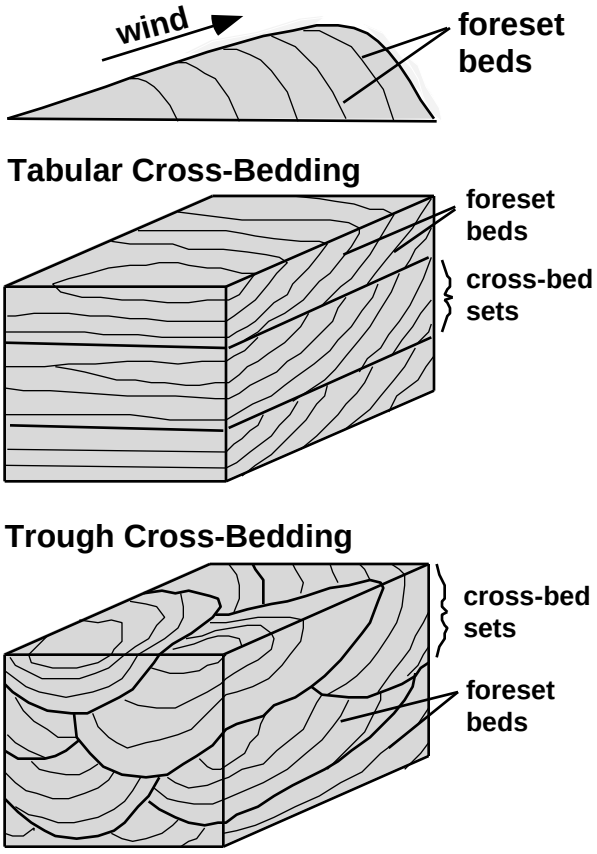

Figure 4. Two major types of cross-bedding.

or underwater as migrating sandbars or sand waves. Different types of cross-beds form depending on factors such as the energy of the system, morphology of the sand dune and the agent of deposition (wind or water). Eolian cross beds are typically very large with cross-bed sets up to 35 meters. The dip of the foreset beds is steep, between 20º and 30º (Prothero, 1990). The Kayenta Formation, which occurs between the Wingate and the Navajo, represents a period when the climate became more humid and was deposited in a broad alluvial plain. Distinct facies within the Kayenta represent braided streams, flood plains, and lake environments. Because of this wide range in depositional subenvironments the Kayenta is more variable consisting of interbedded sandstones, siltstones and mudstones with a range of colors including red, brown and gray. The sandstones within this unit occur as lenses and are cross-bedded. Compared to the Wingate Sandstone, the cross-bedding within the Kayenta is smaller scale and the dip of the foreset beds is lower, reflecting its deposition by water rather than wind. Other sedimentary structures common within the Kayenta include ripple marks, mudcracks and dinosaur footprints.

Paleontology

The Jurassic Morrison Formation outcrops at the higher elevations of Colorado National Monument. It is composed of relatively soft varicolored mudstones and siltstones and tends to form gentle slopes. Where it is unprotected by resistant overlying strata it may become intricately eroded into a badlands topography which can be observed in the Redlands area east of the monument. Although no dinosaurs have been discovered at the monument a number of significant discoveries have occurred nearby. The first skeleton of *Brachiosaurus*, the giant plant-eating behemoth was discovered at Riggs Hill just east of the monument in 1900.

The paleontology exhibits of the Museum of Western Colorado are housed at the **Dinosaur Valley Museum** in downtown Grand Junction, CO. The big attraction here, frankly, is the plethora of half-size moving dinosaur replicas. Don't miss the reaction of young children who will probably be in the museum at the same time that we will be there. You can also usually see dinosaur remains being prepared, that is being cleaned of rock matrix.

References

Kiver, E. P., and D. V. Harris, 1999, *Geology of U. S. Parklands.*, 5th Edition. John Wiley & Sons NY, p. 419-428.

Lohman, S. W., 1963, *Geologic map of the Grand Junction area, Colorado.* U. S. Geological Survey, Misc. Investigations Map I-404

Lohman, S. W., 1981, *The geologic story of Colorado National Monument*:. U. S. Geological Survey Bulletin 1508, 142 p.

Prothero, D. R., 1990, *Interpreting the Stratigraphic Record*: W. H. Freeman & Co., NY, 410 p.

Exercises

Colorado National Monument

1. Compare the views you see along the hiking trails and scenic drive to the geologic map provided in order to determine the erosional characteristics of the following formations:

   Entrada Sandstone (**Je**)

   Kayenta Formation (**Trk**)

   Wingate Sandstone (**Trw**)

   Chinle Formation (**Trc**)

   Precambrian (**pC**)

2. What formation caps Independence Monument?

Dinosaur Valley Museum, Grand Junction, CO

1. Note methods and materials used to prepare fossils at this museum. Are they similar to methods used at Dinosaur National Monument?

Definitions

Define the following terms and give examples of each feature.

Crossbed

Nonconformity

Monocline