AIPG Colorado Section - Field Trip Guide: Geology of the I-70 Road Cut and Dakota Hogback near Morrison, Colorado

Field Trip Date/Time: Saturday, September 13, 2025, 2 pm

Meeting Location: T-Rex Parking Lot, (39.701681084538535, -105.2035005904707)

Field Trip Guide prepared by Jessica Cutter, AIPG MEM-3242, Colorado Section President 2025

Introduction

This field trip examines the spectacular exposures of the Dakota Hogback along Interstate 70 near Morrison, Colorado. The hogback represents the easternmost outcrop of resistant sandstones formed during the Cretaceous Period, which were tilted during the Laramide Orogeny. Here, classic relationships between the Morrison Formation, the Dakota Group, and the Benton Shale are visible in sharp relief. The I-70 road cut is a fantastic location to observe stratigraphy and structure, and provides students, professional geologists, and the general public with access to observe and study these important geological formations.

Figure 1: Photograph of the I-70 road cut with a view of the walking path on the north side of I-70, from: http://www.jsjgeology.net/Dinosaur-Ridge.htm

Educational Objectives:

- Recognize stratigraphic contacts between key Jurassic and Cretaceous formations that make up the hogback.
- Interpret depositional environments from sedimentary structures.
- Observe structural features related to the uplift of the Front Range.
- Discuss geomorphic processes shaping the hogback.

Safety Note: Exercise caution near steep exposures and traffic. Stay in designated safe areas. Watch for loose rock and uneven ground.

Regional Geologic Setting

The Dakota Hogback marks the boundary between the Great Plains and the Rocky Mountain Front Range. During the Laramide orogeny (~70–40 Ma), compressional forces uplifted the Ancestral Rockies, tilting sedimentary strata eastward. The Dakota Hogback formed where resistant sandstone layers dip steeply, standing above softer shales and mudstones that erode more easily.

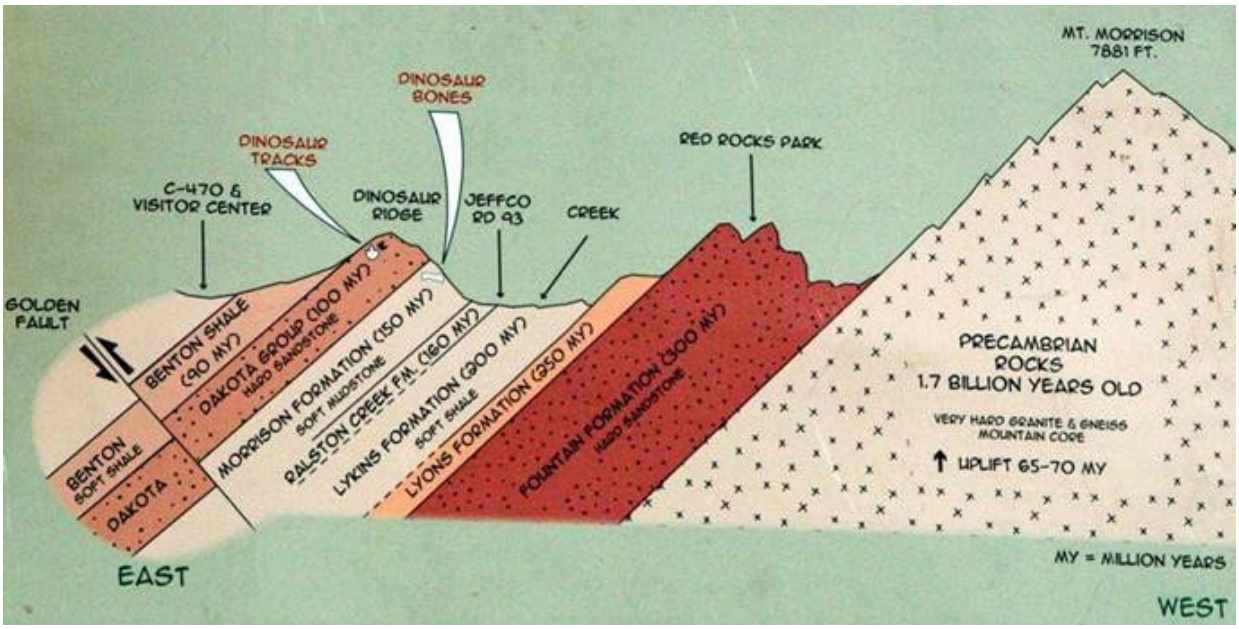

Figure 2: Generalized cross-section of the Front Range, from: http://www.jsjgeology.net/Dinosaur-Ridge.htm

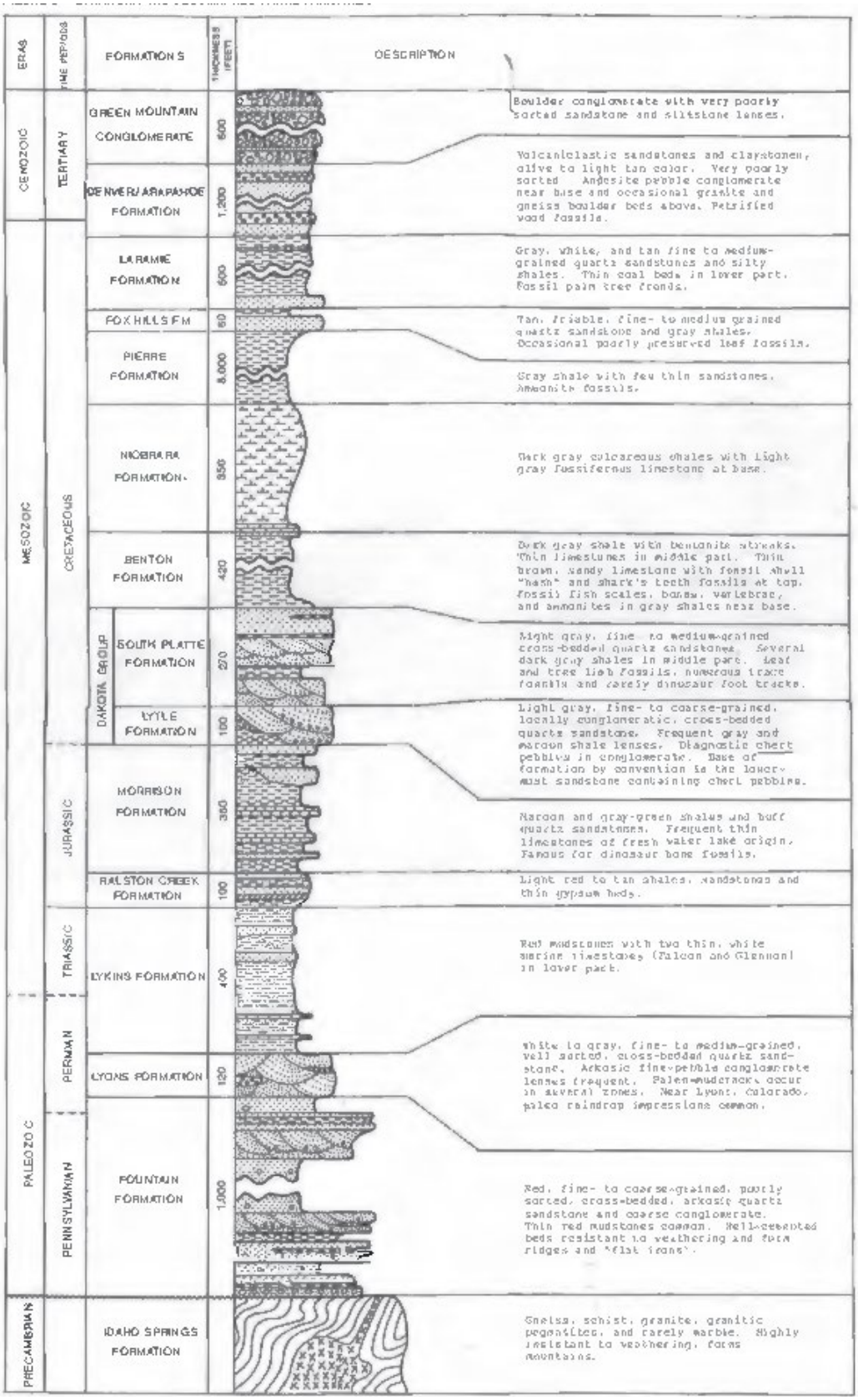

Figure 3: Stratigraphic column, Red Rocks Park Area, from: Taylor, A. (1992)

Question:

➡️ Why do you think sandstone forms a ridge while shale forms valleys?

Stratigraphy Overview

Morrison Formation (Jurassic, ~150 Ma)

- Composition: Maroon and gray-green shales and buff quartz sandstones. Frequent thin limestones of freshwater lake origin (Taylor, A., 1992).
- Depositional Environment: floodplains, rivers, meandering streams, and lakes.
- Significance: world-famous for dinosaur fossils.
- Outcrop Appearance: green, gray, and reddish shales with sandstone lenses at the base of the hogback.

Question:

➡️ Know your fossils! What is the Colorado state fossil?

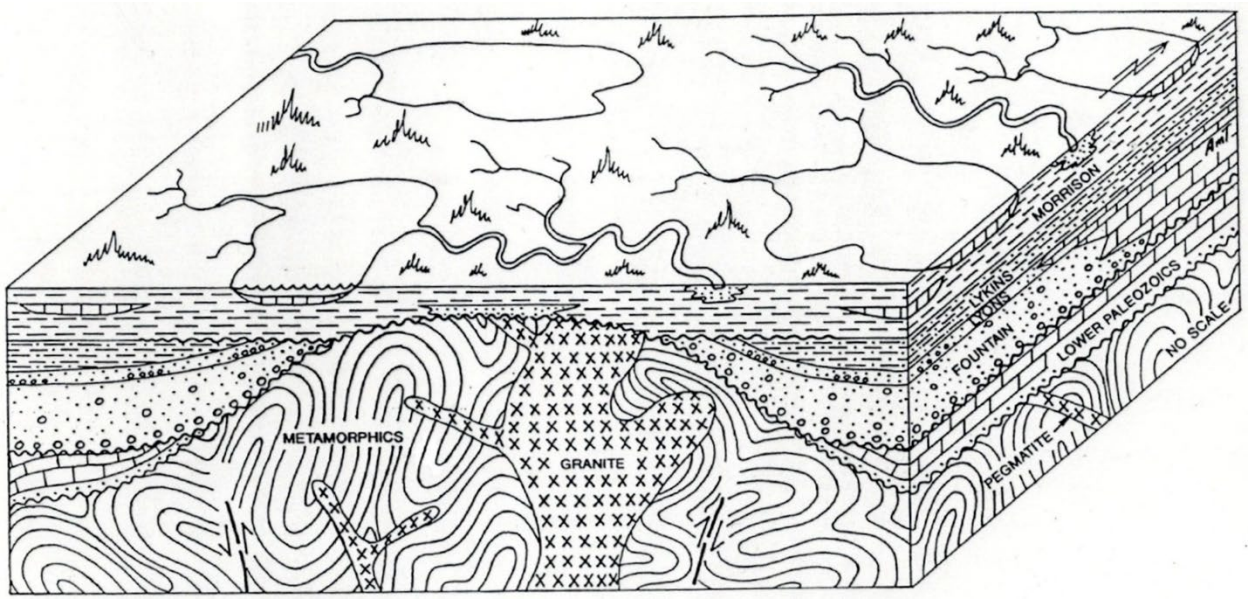

Figure 4: Block diagram, deposition of the Jurassic Morrison Formation, from: Taylor, A. (1992)

Dakota Group – Lytle SS and South Platte SS (Early Cretaceous, ~130 Ma - 100 Ma)

- **Lytle Sandstone:**
    - Composition: light gray, fine- to coarse-grained, locally conglomeratic, cross-bedded quartz sandstones. Frequent gray and maroon shale lenses. Diagnostic chert pebbles in conglomerate. Base of formation by convention is the lower-most sandstone containing chert pebbles (Taylor, A., 1992).
    - Features: cross-bedding, ripple marks.
    - Depositional Environment: coastal plain (western CO), coastal floodplain (eastern CO).
- **South Platte Sandstone:**
    - Composition: Light gray, fine- to medium-grained cross-bedded quartz sandstones. Several dark gray shales in middle part. Leaf and tree limb fossils, numerous trace fossils and rarely dinosaur foot tracks (Taylor, A., 1992).
    - Features: cross-bedding, ripple marks (three types: symmetrical, interference, and asymmetrical), and preserved dinosaur tracks.
    - Depositional Environment: transitional, deltas and tidal flats (wide beaches). Deposited during period of transgression.
- Outcrop Appearance: thick, buff to tan cliff-forming sandstones.

Question:

➡️ Look for ripple marks or cross-beds. Which direction was the water flowing when these formed?

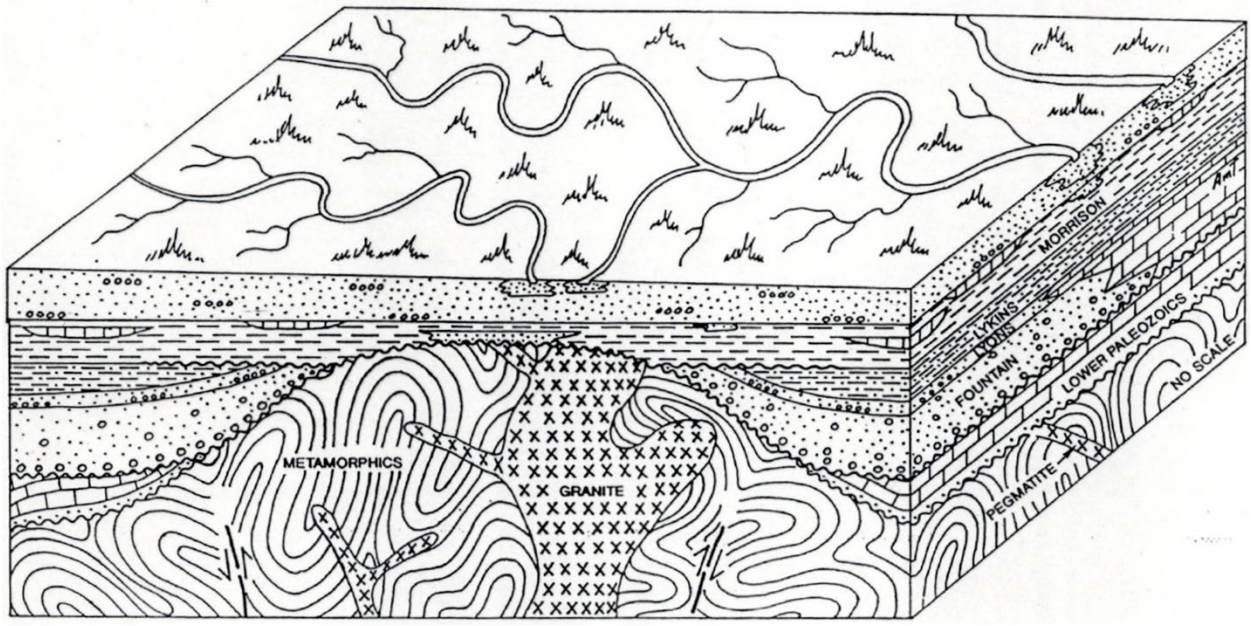

Figure 5: Block diagram, deposition of the Cretaceous Lytle Formation, from: Taylor, A. (1992)

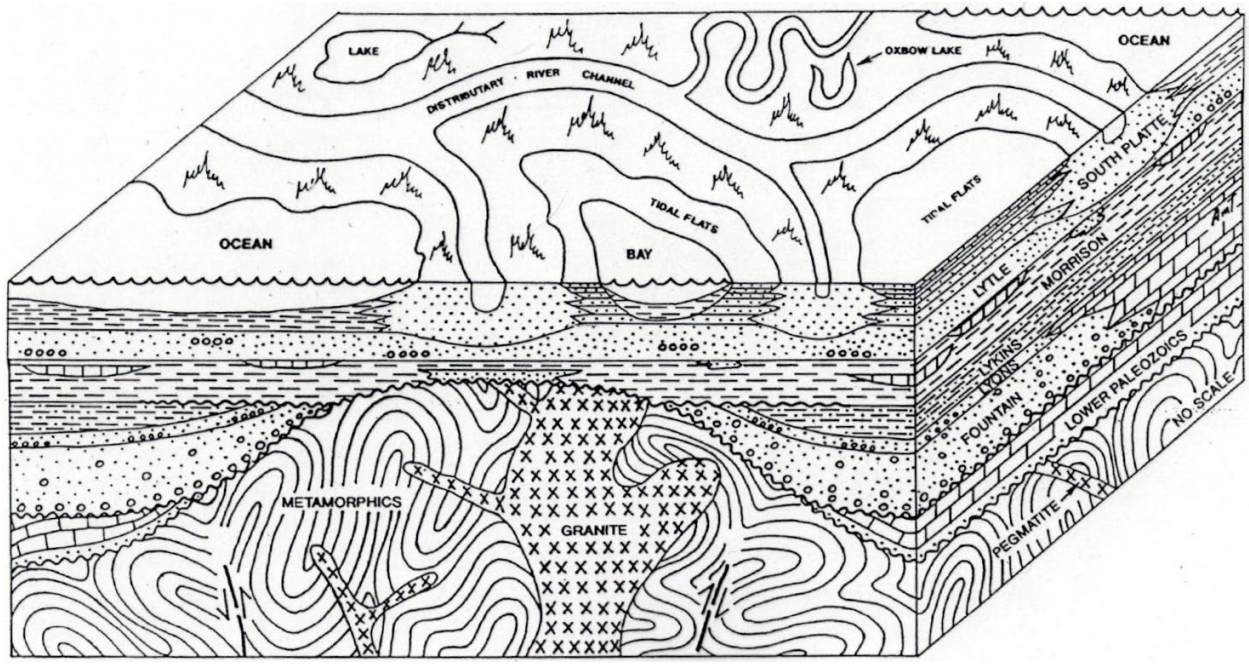

Figure 6: Block diagram, deposition of the Cretaceous South Platte Formation, from: Taylor, A. (1992)

Benton Shale (Cretaceous, ~95 Ma)

- Composition: dark gray shale with bentonite streaks. Thin limestone in middle part. Thin brown, sandy limestone with fossil shell “hash” and shark’s teeth fossils at top. Fossil fish scales, bones, vertebrae, and ammonites in gray shales near base (Taylor, A., 1992).
- Depositional Environment: offshore marine environment during a major sea-level rise (during transgression).
- Significance: contains bentonite (volcanic ash altered to clay).
- Outcrop Appearance: soft, easily weathered slope-forming material.

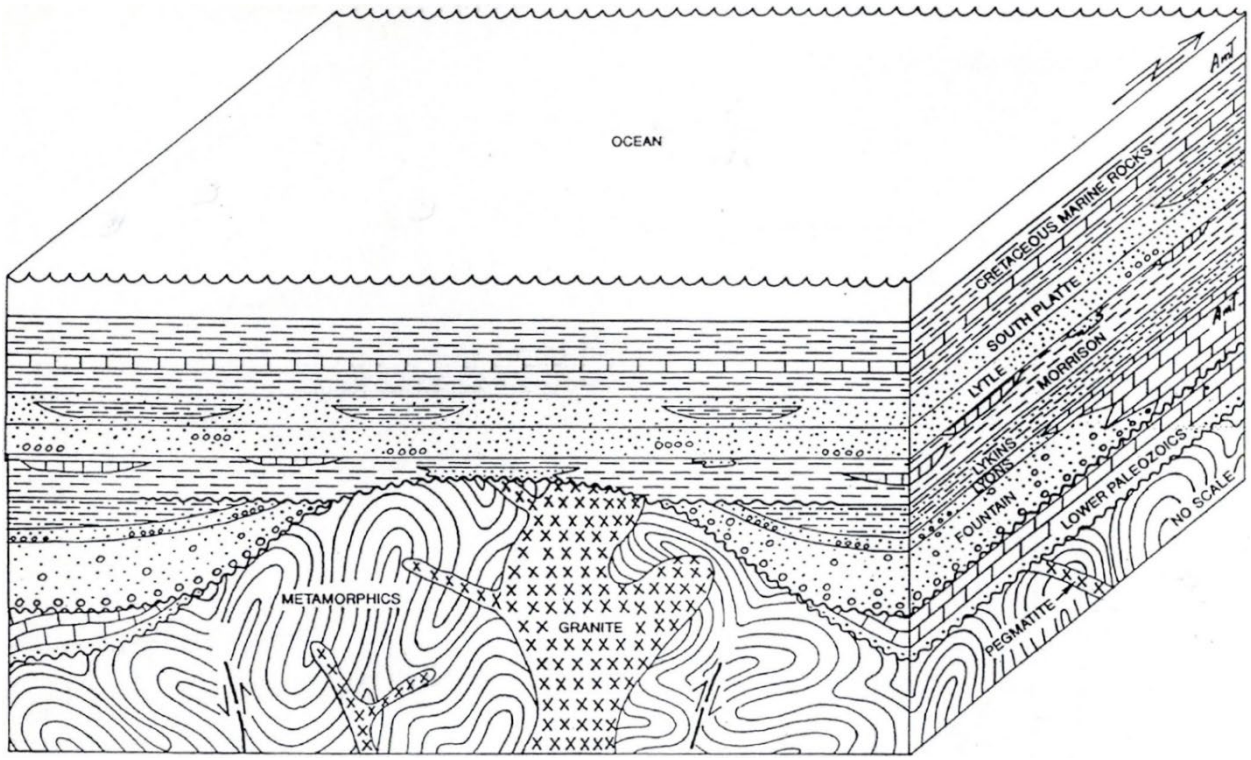

Figure 7: Block diagram, deposition of the Cretaceous Marine Rocks, from: Taylor, A. (1992)

Question:

➡️ Observe the colors. What indicates that this is a marine shale?

Sedimentary Structures & Fossils

- **Ripple Marks & Cross-Beds:** evidence of shallow-water currents and wave action.
- **Coal & Carbonaceous Shales:** swampy environments in deltaic plains.
- **Dinosaur Tracks:** preserved in Dakota sandstones (e.g., near Dinosaur Ridge).
- **Plant Fossils:** leaf impressions recording Cretaceous coastal vegetation.

Question:

➡️ If you found both marine fossils (clams) and dinosaur tracks in the same formation, how might you explain their coexistence?

Structural Geology

The Dakota Hogback dips steeply eastward, reflecting tilting during the Laramide orogeny.

- **Strike and Dip:** strata typically dip ~40–70° east.
- **Faulting:** local normal and reverse faults are visible in some road cut sections.
- **Folds:** broad arching of the hogback ridge reflects compression and uplift.

Question:

➡️ Measure dip angle with a compass-clinometer. What does this tell us about the intensity of deformation?

Question:

➡️ Visualizing strike and dip. How do you explain apparent dip versus true dip? How does this relate to this location?

Geomorphology

- **Hogback Formation:** results from differential erosion — sandstones resist weathering, while adjacent shales erode quickly.
- **Slope Processes:** rockfall and mass wasting shape the steep faces.
- **Modern Landscape Evolution:** the hogback acts as a topographic and hydrologic boundary, influencing drainage patterns.

Economic & Historical Significance

- **Building Stone:** Dakota sandstone was historically quarried for construction, and is seen in many buildings throughout the region.
- **Bentonite:** used in drilling muds, foundry work, and as absorbents.
- **Oil and Gas:** the South Platte Sandstone is a reservoir for oil and gas resources, primarily in the DJ Basin.
- **Uranium and Vanadium:** the Morrison Formation has been mined throughout state history for uranium and vanadium in Southwest Colorado.
- **Scientific Importance:** the discovery of dinosaur fossils along the hogback in the Morrison Formation during the late 19th century was pivotal to paleontology – Morrison was one of the locations of the famed Bone Wars!

Field Trip Stops

1. **Stop 1 – Base of Hogback (Morrison Formation):**

Examine mudstones and sandstones; note color variations and depositional features.

Prompt: What environments do these colors suggest (red = oxidizing floodplain; green/gray = reducing conditions)?

What other observations can you make?

2. **Stop 2 – Dakota Sandstone Cliffs:**

Observe cross-bedded sandstones and ripple marks.

Prompt: Can you distinguish tidal vs. river cross-beds?

What other observations can you make?

3. **Stop 3 – Benton Shale:**

Contrast soft shale slopes with the resistant sandstones above and below.

Prompt: What role did sea-level rise play in depositing this unit?

What other observations can you make?

Additional Discussion Questions

- How do the Dakota sandstones preserve evidence of both terrestrial and marine processes?
- In what ways does the hogback reflect a balance between tectonics and erosion?
- How does this outcrop compare with equivalent strata farther north (e.g., near Golden or Boulder)?

References & Further Reading

- Cronoble, J. (2018). *Geology of Red Rocks Park and Vicinity.*
- Chronic, H. (1980). *Roadside Geology of Colorado.*
- Lockley, M. (1990). *The Dinosaurs of Dinosaur Ridge.*
- Taylor, A. (1992). *Guide Book to the Geology of Red Rocks Park and Vicinity.*
- Tweto, O. (1979). *Geologic Map of Colorado.* USGS.

Cover photo from https://robertjprince.net/2021/05/31/the-cut-in-i-70-at-morrison-the-geology-of-colorados-dakota-hogback/

Geology of Red Rocks Park and Vicinity

(Revised 10/01/18)

	Formation	Geologic Age	Principal Rock Type(s)	Depositional Environment	Economic Products	Remarks
	Green Mountain Conglomerate	Early Tertiary	Conglomerate w/gneiss and granite cobbles	Alluvial Fans	--	• Lies horizontal. • Derived from core (Idaho Springs) of Rocky Mtns.
	Denver/ Arapahoe Formation	Latest Cretaceous/ Early Tertiary	Conglomerates Shales Sandstones	Alluvial Fans	Fresh Water	• Derived from rising Rocky Mountains.
Beginning Uplift of Current Rocky Mtns "Laramide Orogeny"		Latest Cretaceous	**Angular Unconformity (not exposed)**			• Current Rockies trend north-south.
	Laramie Formation	Late Cretaceous	Shales (Clay) Quartz Sand-stones, Coals	Coastal Flood Plain	Clay and Coal	• **End of Regression.** • Swamps – coal-forming environments. Dinosaur footprints/plant fossils
	Fox Hills Sandstone	Late Cretaceous	Quartz Sandstones (Weakly Cemented)	Transitional (Beach, Barrier Island, Offshore Bars?)	Fresh Water	• **Regression.** • Concretions – concentric cementation around organic material.
	Pierre Shale	Late Cretaceous	Marine Shale	Marine	Melted to make light-weight aggregate	• **Regression.** • Lots of bentonite. • Soil Creep.
	Niobrara Limestone	Late Cretaceous	Marine Limestones	Marine	Oil and Gas	• **Beginning of Regression.** • **End of Transgression.** • Ocean reached its maximum geographic distribution. • Inoceramus clam fossils.
	Benton Shale	Late Cretaceous	Marine Shale	Marine	--	• **Transgression.**
Dakota Group Hogback formed because sandstones are more resistant to weathering than shales above and below.	South Platte Sandstone	Early Cretaceous	Quartz Sandstones	Transitional: Deltas and tidal flats (wide beaches)	Oil and Gas	• **Transgression.** • 106 myo layer of Porcelinite • Some layers bioturbated by trace fossils, including dinosaur footprints. • 3 ripple types: symmetrical, interference, asymmetrical.
	Lytle Sandstone	Early Cretaceous	Quartz Sandstones	Coastal Plain (west) to Coastal Floodplain (east)	--	• Eastward tilting. • Braided streams

Eastward Regional Tilting – caused coarser material to be eroded from Sevier Uplift of western Utah and transported to east, deposited as Lytle Sandstone						
	Morrison Shale	Late Jurassic	Greenish-gray shales, some qtz sandstones and fresh-wtr limestones	Flood Plain: Meandering streams and flood plains	Vanadium and Uranium Southwest Colorado	• Dinosaur fossils – There was a climate change to more tropical.
	Ralston Ck Formation	Late Jurassic	Gypsum (Gdn of Gods)	Salt Flat	--	Not a true formation because it is not mappable.
A disconformity with about 80 million years of time and rocks missing from Mid Triassic to Late Jurassic.						
Continued	**Formation**	**Geologic Age**	**Principal Rock Type(s)**	**Depositional Environment**	**Economic Products**	**Remarks**
Wearing down of the Ancestral Rocky Mountains	Lykins Mudstone	Late Permian/ Early Triassic	Red Mudstones	Coastal Flood Plain: Meandering streams and flood plains	--	• Meandering streams cut laterally. • Contains two marine limestone members – Ocean transgressed twice over coastal flood plain.
	Lyons Sandstone	Middle Permian	Quartz Sandstones	Coastal Plain: Braided streams and eolian sand dunes	Building Stone	• Paleo Raindrop Impressions, Mudcracks, and Eolian Sand Dunes – signs of an arid climate. • Wide, braided streams choked with sediment. • Garden of the Gods
	Fountain Arkose	Early Penn to Early Permian	Arkose (Feldspar-rich)	Alluvial Fans: Braided streams and debris flows	--	• High, close source area. • Cemented by iron-oxide-rich clay. • Red Rocks Park, Flatirons, and Roxborough Park
Uplift of Ancestral Rocky Mountains during the Early Pennsylvanian, including Ancestral Front Range and Uncompahgre			**A nonconformity is present between the Fountain Arkose and Precambrian-aged rocks from north of Boulder to the south of Deer Creek**			• Northwest-southeast trend • Formed from collision of two huge continents. • Uplift began during Early Pennsylvanian.
	Idaho Springs Formation	Precambrian	Gneisses and Schists	Metamorphic Rocks – No depositional environment.	Constructio n Gravel	• Formed 1.7 billion years ago during a plate collision. • Light-colored mineral layers in gneisses are quartz and orthoclase feldspar and dark-colored layers are iron-rich biotite and hornblende.