



## The Geologic Story of the Badlands



*The White River Badlands are composed of jagged buttes, deep canyons, towering spires, and flat-topped tables - all of which are the result of the millions of years of geologic processes that shaped this land in the past and continue to do so today!*

**Introduction** The geologic story of Badlands comes in two parts: (1) the building up of the rock layers that make up the buttes (deposition), and (2) the carving away of these rock layers (erosion). Think of this geologic story like a book – each layer is a page, each rock formation is a chapter, and together they weave a story about the dramatic past of this landscape.

### Helpful Definitions

- **Deposition** – The accumulation of sediments (bits of rock, sand, silt, clay, and/or organic materials).
- **Sedimentary Rock** – A type of rock formed from the deposition of sediments that later solidify.
- **Erosion** – The process by which wind, water, and gravity remove bits of rock and soil over time.

\*Keep in mind, these processes are interconnected! To have deposition, erosion must first take place. To form sedimentary rocks, sediments must be deposited. For erosion to occur, there must be rocks (sedimentary rocks included) to erode.

### PART I: Deposition

#### Chapter 1: Marine Deposition

From 75 to 69 million years ago, a shallow sea called the Western Interior Seaway covered the Great Plains, including the area that is now Badlands National Park. Over millions of years, clay accumulated on this ancient seafloor and later solidified to form the Pierre Shale, which contains numerous marine fossils. As the Rocky Mountains began to uplift, central North America was raised above sea level, causing the Western Interior Seaway to recede. When the Pierre Shale was exposed to the air for the first time, the uppermost portion was chemically altered through weathering and soil formation processes over millions of years. This resulted in a yellow-colored rock formation, aptly named the Yellow Mounds.

#### Chapter 2: Missing Time

At the boundary between the Yellow Mounds and the rock formation above it, there are 32 million years (from 69 to 37 million years ago) of time not recorded in the rock record at Badlands. This phenomenon is called an unconformity. If the geology of Badlands is like a book, then the unconformity is like a chapter that has been torn out – it's not that the pages never existed, they were simply removed before the following chapters were written.

#### Chapter 3: Terrestrial Deposition

The Chadron, Brule, and Sharps Formations are all mudstones/siltstones primarily composed of sediment eroded from the Black Hills (west of the Badlands). The sediment that created these formations was transported via rivers, wind, and gravity to the low-lying Badlands area between 37 and 28 million years ago where it was deposited in vast layers. The red layers or “paleosols” of the Badlands are fossilized soils, and each one used to be the surface of the ancient landscape here that transitioned over ~10 million years from a hot, humid, swampy environment to a semi-arid grassland. These terrestrial rock formations contain many fossils that record mammal evolutionary responses to changes in climate.

### PART II: Erosion

The dramatic, jagged landscape of the Badlands was carved out by erosion, not built up like a mountain. About 500,000 years ago, the White River (now located south of the park) cut into the landscape, exposing the soft rocks of the Badlands to the elements. Though wind and gravity contribute, water is the main driver of Badlands erosion. The semi-arid Badlands do not receive much precipitation, but even a small amount of water can carry a large amount of suspended sediment. Rainwater that runs through the Badlands drains into the White River, bringing plenty of sediment with it and causing the river to run white.

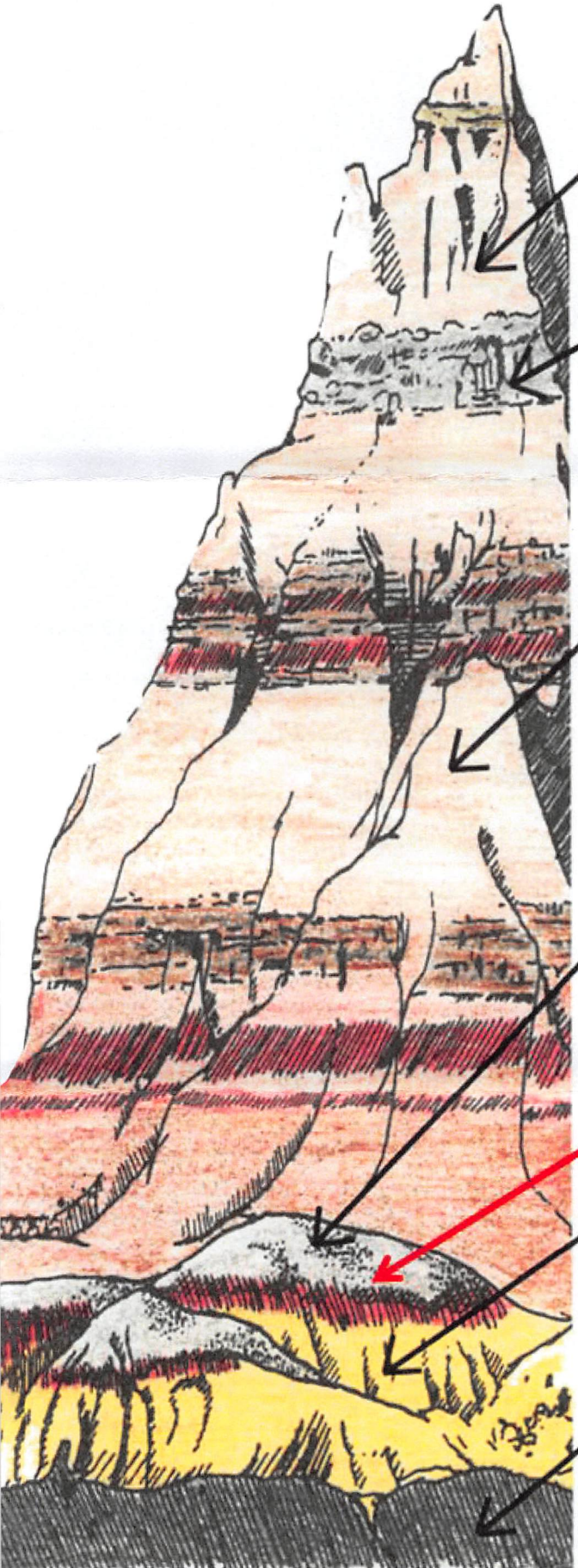
### Epilogue

Geology is a never-ending story. Even today, Badlands erodes at about one inch per year! Compared to the Black Hills (which erode one inch every 10,000 years), the Badlands formations are rapidly disappearing. At this rate, Badlands National Park will be eroded into flat prairie in another half million years. As the Badlands erode, fossils are always being uncovered. Since visitors are allowed to safely explore both on and off-trail in the park, they are encouraged to look for fossils but must leave their finds in place, take photographs, and report them at the visitor center or email them to [badlands\\_fossil\\_finds@nps.gov](mailto:badlands_fossil_finds@nps.gov).

**\*It is illegal to collect, move, or remove fossils, rocks, artifacts, or plants from Badlands National Park \***

# Rock Formations of Badlands National Park

From 75 to 28 million years ago...



## Sharps Formation

- Deposited 30 to 28 million years ago.
- Composed of sediment eroded from the Black Hills and deposited at Badlands by rivers and wind.
- Climate was cooling and drying.

## Rockyford Ash / Cedar Pass White Layer

- Deposited 30 million years ago.
- From a volcanic eruption in Nevada/Utah 5 to 6 times the size of a Yellowstone eruption!

## Brule Formation

- Deposited 34 to 30 million years ago.
- Composed of sediment eroded from the Black Hills and deposited here by wind and water.
- Climate began to dry and cool, forests turned to open scrubland and grassland.
- Red layers are fossilized soils or paleosols.

## Chadron Formation

- Deposited 37 to 34 million years ago.
- Composed of sediment eroded from the Black Hills and deposited here in a river flood plain.
- Rich in volcanic ash.
- Climate was a sub-tropical swampy forest, like modern-day Florida.

**Unconformity** - 32 million years of missing time!

## Yellow Mounds Formation

- Upper section of the Pierre Shale that oxidized to a yellow color when the sea retreated.
- An example of a fossil soil or *paleosol*.

## Pierre Shale Formation

- Deposited 75 to 69 million years ago.
- Composed of clay deposited in the shallow inland sea that once covered the Great Plains.

Oligocene

Eocene

Cretaceous