

# BADLANDS HIKE

## Teacher Resource Guide

### Program Overview

**TOPIC:** Geology, palaeontology, and natural history of the Alberta badlands.

**THEME:** Discover the rocks, fossils, and natural features of the badlands environment

**PROGRAM DESCRIPTION:** Students will explore the unique badlands landscape, taking an in-depth look at the environment, and the plants and animals it supports. By closely examining the fossil and rock evidence present, students will be able to describe how the landscape and climate have changed over time.

**AUDIENCE:** Kindergarten – Grade 12

### Curriculum Connections

Kindergarten	<b>Science:</b> Using Senses to Explore Properties; Examine and Describe Environments
Grade 1	<b>Science:</b> Environmental Change; Needs of Plants and Animals
Grade 2	<b>Science:</b> Earth and Landforms; Growth of Animals and Plants
Grade 3	<b>Science:</b> Earth and Landscape Changes; Plant and Animal Interactions
Grade 4	<b>Science:</b> Earth Systems; Organism Classification and Functions
Grade 5	<b>Science:</b> Climate and Weather
Grade 6	<b>Science:</b> Climate Change; Ecosystems
Grade 7	<b>Science:</b> Planet Earth; Interactions & Ecosystems
Grade 8	<b>Science:</b> Freshwater and Saltwater Systems
Grade 9	<b>Science:</b> Biological Diversity
Grade 10	<b>Science 14:</b> Investigating Matter and Energy in the Environment
Grade 11	<b>Science 20:</b> The Changing Earth; <b>Bio 20:</b> Ecosystems and Population Change
Grade 12	<b>Bio 30:</b> Population & Community Dynamics

## Program Objectives

Students will be able to:

1. Describe how the badlands landscape was formed through geological processes.
2. Explore the features that make the badlands a unique environment.
3. Identify different types of sedimentary rocks, and understand which palaeoenvironment they represent.
4. Describe the climate of this area during the time of dinosaurs (70 million years ago).
5. Identify characteristics of the ecosystem today, including the adaptations of modern plants and animals to survive in this environment.

## Suggested Pre-Visit Activities

### 1. PROGRAM TERMINOLOGY

Here are some terms to introduce to your class before you attend your program at the Royal Tyrrell Museum. These terms will prepare the students so they get the full benefit of the program.

**Badlands:** arid terrain dominated by soft sedimentary rocks; in the late 1800s, this landscape was deemed difficult to travel through and unsuitable for agriculture. Geological formations such as canyons, ravines, gullies, and hoodoos are common in the badlands.

**Bentonite:** clay particles generated by the alteration of ancient volcanic ash.

**Coal:** results from the compression of accumulated peat in ancient swamps. The Drumheller area contains sub-bituminous coal.

**Coulee:** from the French word couler, meaning “to flow.” Coulees are narrow, steep-walled drainage channels that feed into valleys.

**Cretaceous Period:** the third and most recent period of the Mesozoic Era, from 143 – 66 million years ago.

**Deposition:** the accumulation of sediments.

**Ecosystem:** A complex system of interactions between a community of living organisms and their environment.

**Erosion:** the movement of rock material away from its point of origin, by water, ice, wind, and gravity.

**Erratics:** rocks that are mostly igneous or metamorphic that have been transported through glacial action and deposited after meltwaters have receded.

**Fossilization:** the process that preserves the remnants, impressions, or traces of an organism in rock, over time.

**Geology:** the scientific study of the origin, history, and structure of the Earth.

**Glaciation:** the scouring and wearing down of the Earth through erosion and deposition by glaciers.

**Habitat:** the natural home or environment of an animal, plant, or organism. Habitat is the component of a landscape that a wildlife population needs to maintain its existence. It may involve factors such as proper moisture, food, shelter, pH, etc.

**Hoodoo:** a mushroom-shaped rock formation that is caused by differential resistance to weathering and erosion.

**Igneous Rock:** rock formed from the solidification of cooled magma (molten rock).

**Ironstone:** a sedimentary concretion or nodule formed by the chemical precipitation of iron carbonates or iron oxides from mineral-rich groundwater.

**Joseph Burr Tyrrell:** (pronounced TEER-uhl). A Canadian geologist, cartographer, and mining consultant who accidentally discovered dinosaur (*Albertosaurus*) fossils in Alberta's badlands near Drumheller in 1884. He had been sent to the area by the Geological Survey of Canada to look for coal.

**Metamorphic Rock:** rocks formed when pre-existing rocks are altered by heat and/or pressure.

**Mineral:** a naturally occurring inorganic substance that has a definite chemical composition and crystalline structure.

**Mudstone:** sedimentary rock formed from the deposition of fine particles of mud in low-energy environments (slow-moving water).

**Palaeoenvironment:** environment of the ancient past.

**Palaeontology:** the study of ancient plant and animal life through the fossil record.

**Rock:** a naturally occurring solid composed of minerals.

**Sandstone:** sedimentary rock formed from the deposition of sand in high-energy environments (flowing water). Drumheller sandstone is white in appearance.

**Sedimentary Rock:** rocks formed by the accumulation and consolidation of mineral and/or organic fragments that have been deposited by water, ice, or wind.

**Sediments:** solid materials that are the result of weathering and erosion.

**Stratigraphy:** the study of rock layers, their formation, composition, and sequence.

**Weathering:** the breakdown of parent rock material by natural forces into loose components (sediments). May be caused by mechanical (e.g., UV radiation), biological (e.g., lichen), or chemical (e.g., oxidation) forces.

## 2. BADLANDS BRAINSTORM

The badlands are classified as a semi-arid desert. This means that the area receives very little precipitation. Because of the lack of water, only certain types of plants and animals can live there. As a class, discuss what you might see along your hike in the badlands. What kinds of plants will you see? Will there be any animals out and about? Which ones will be hiding from your sight? Don't forget to think about the types of rocks that are found in the badlands.

<http://en.wikipedia.org/wiki/Badlands>

[Alberta's Natural Regions](#)

**Keywords:** Canadian badlands, Alberta badlands

## 3. RULES OF THE TRAILS

The Badlands Hike takes place near the Royal Tyrrell Museum, located in Midland Provincial Park. Brainstorm with your class about what sort of rules are in place to protect provincial parks. What is protected in the park? What are you allowed to do? What are you not allowed to do? How do you stay safe while hiking in a park? What should you bring on a hike?

Midland Provincial Park is very rich in fossils, which is one of the reasons the Royal Tyrrell Museum was built here. Alberta's *Historical Resources Act* protects these and all other fossils in the province. Do some research to learn about how Alberta's fossils are protected. What are you allowed to do with fossils and what aren't you allowed to do? Are there any penalties for breaking the laws protecting fossils?

[https://tyrrellmuseum.com/research/found\\_a\\_fossil](https://tyrrellmuseum.com/research/found_a_fossil)

<https://www.albertaparks.ca/>

[Government of Alberta Historical Resources Act](#)

**Keywords:** Alberta fossil laws, Royal Tyrrell Museum fossil laws, Alberta parks, Midland Provincial Park

### *Links to other websites*

*Links to websites are provided solely for your convenience. The Royal Tyrrell Museum does not endorse, authorize, approve, certify, maintain, or control these external Internet addresses and does not guarantee the accuracy, completeness, efficacy, or timeliness of the sites listed.*

## Post-Program Activities

### 1. BADLANDS POP QUIZ

#### Rocks

Name three types of sedimentary rocks found in the Drumheller Valley badlands.

- 1 \_\_\_\_\_
- 2 \_\_\_\_\_
- 3 \_\_\_\_\_

Describe the palaeoenvironment in which two of these rock types were formed.

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#### Bentonite Clay/Popcorn Rock

List three uses of bentonite clay.

- 1 \_\_\_\_\_
- 2 \_\_\_\_\_
- 3 \_\_\_\_\_

Where does bentonite clay come from?

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#### Hoodoos

Hoodoos are formed through the processes of \_\_\_\_\_ and \_\_\_\_\_. During these processes, \_\_\_\_\_ and \_\_\_\_\_ gradually wear away the sediments from the surrounding rock. A hard \_\_\_\_\_ protects softer rock beneath it, allowing mushroom-shaped hoodoos to form.

## Dinosaur Fossils

Name one of the most common dinosaur families found in the Drumheller Valley.

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Why is erosion good for palaeontologists?

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## Petrified Wood

What does petrified wood tell us about the ancient climate of the Drumheller area? Describe how the modern climate is different.

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Relatives of these ancient trees are still alive today. Where can they be found?

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## Glacial Erratics

Where were the glacial erratics originally formed and how did they get to the Drumheller Valley?

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Describe how the Drumheller Valley was formed.

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*Geomorphology of Alberta*

*Badlands Formations*

**Keywords:** Alberta geology, Alberta glaciation

## Prickly Pear Cactus & Sagebrush

List some adaptations that prickly pear cacti or silver sagebrush have to survive in their environment.

1 

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2 

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3 

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## 2. LANDSCAPE CONSERVATION

Describe examples of personal actions that contribute to conservation in daily life.

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## 3. FROM SAND TO STONE ACTIVITY

Sedimentary rock is one of the three major classes of rocks on Earth. Fossils are found within this type of rock. There are many different sedimentary rocks around the world today.

**Required Materials:** Samples of sand, gravel, and fine soil; marker or pen; large wide-mouthed jar (750 mL to 1 L size) with lid; water.

### Activity Instructions:

1. Fill the jar about 1/3 full of water. Mark the level on the side of the jar. Measure out an equal volume amount of each sediment type (e.g., 1 cup). Add the gravel, sand, and soil, one at a time, in that order. Before you release each sediment into the jar, make a quick prediction whether it will be more buoyant (it floats) or less buoyant (it sinks) than the water.
2. Seal the jar with the lid.
3. With one hand under the jar and the other over the lid, give the jar 10 vigorous shakes to mix all the contents together.
4. Place the jar in a place where the contents can settle undisturbed for at least one hour.
5. Complete the following tasks and questions in your notebook: sketch the jar and its contents just after you finish shaking. After the sediments have settled, sketch the jar and its contents again.
  - a) How do the two sketches compare?
  - b) Why did the sediments settle the way they did?
  - c) Which of the three sediment types is the least dense?
  - d) How does this relate to the badlands?

## Post-Program Activities Answer Key

### 1. BADLANDS POP QUIZ

#### Rocks

Name three types of sedimentary rocks found in the Drumheller Valley badlands:

Possible answers include: ironstone, sandstone, siltstone, shale, mudstone, or coal

Describe the environment in which two of these rock types were formed.

Answers vary, but include: accumulations or depositions in stagnant swamps, slow-moving or fast-flowing waters, and chemical precipitation.

#### Bentonite Clay

List three uses of bentonite clay.

Answers vary, but include: used in the mining industry as a drilling mud, used in the personal care industry as skincare, used in the pet industry as cat litter, used in the health food industry as a dietary supplement, used in the construction industry for waterproofing and as sealing agents, and used in science as a way of doing radiometric dating on rock layers.

Where does bentonite clay come from?

It originated as volcanic ash from volcanoes located hundreds or thousands of kilometres away in the Cretaceous Period.

#### Hoodoos

Hoodoos are formed slowly through the processes of weathering and erosion. During these processes, UV rays, freeze-thaw, wind, and rainwater gradually break down and wear away the sediments from the surrounding rock. A hard cap rock protects softer rock beneath it, allowing mushroom-shaped hoodoos to form.

## Dinosaur Fossils

Name one of the most common dinosaur families found in the Drumheller Valley.

Hadrosaurs (also known as duck-billed dinosaurs), and tyrannosaurs, such as *Albertosaurus*.

Why is erosion good for palaeontologists?

It removes rock and exposes fossils that are buried within layers of sediment.

## Petrified Wood

What does petrified wood tell us about the ancient environment of the Drumheller area?

The petrified wood is from *Metasequoia* and indicates that this was a warm, humid forest during the time of the dinosaurs (warm temperate environment).

The modern climate is dry year-round, with low annual precipitation and low humidity. It has extreme temperature changes from hot to very cold. It is a semi-arid environment.

Relatives of these ancient trees are still alive today. Where can they be found?

They can be found in the forests of Hubei, China. Their relatives, the giant sequoias, live on the west coast in northern California. *Metasequoia* can also be found in indoor gardens, like the one at the Royal Tyrrell Museum.

[https://tyrrellmuseum.com/whats\\_on/exhibits/cretaceous\\_garden](https://tyrrellmuseum.com/whats_on/exhibits/cretaceous_garden)

<https://en.wikipedia.org/wiki/Metasequoia>

**Keywords:** metasequoia, dawn redwood

## Glacial Erratics

Where were the glacial erratics originally formed and how did they get to the Drumheller Valley?

The glacial erratics are igneous and metamorphic rocks. Formed in the Canadian Shield and the Rocky Mountains, they were transported to this area by the last glaciers that advanced from the north and west. Describe how the Drumheller Valley was formed: When the glaciers started melting, around 15,000 years ago, large blocks of ice broke off and formed ice dams that held back massive quantities of water. When the dam in this area broke, the meltwater rushed through and cut down into the soft rock, creating the valley.

## Prickly Pear Cactus & Sagebrush

List three adaptations that prickly pear cacti or silver sagebrush have to survive in their environment.

Some possible answers include:

Cacti: Spines to ward off predators; a waxy cuticle on the stem to prevent water loss; the ability to produce a natural anti-freeze so their cells will not be damaged during the cold winter.

Sagebrush: hairy leaves to block UV radiation and heat; small bladed leaves to reduce surface area evaporation of water from inside; strong aroma to ward off predators; deep taproot to absorb groundwater

## 2. LANDSCAPE CONSERVATION

Describe examples of personal actions that contribute to conservation in daily life.

I can reduce, reuse, repurpose, and recycle resources. I can avoid littering or pollution. I can show respect in natural environments by staying on the trails and not altering the landscape. I can leave fossils, berries, insects, and flowers where I find them. I can share my knowledge with others.

### 3. FROM SAND TO STONE ACTIVITY

a) How do the two sketches compare?

The first sketch should show a cloudy mixture with the sediments suspended and swirling in the water. The second sketch, completed after the sediments have settled, should show the gravel at the bottom of the jar, followed by the sand and then the soil on the top.

b) Why did the sediments settle the way they did?

The largest and heaviest sediment type in the mixture is the gravel, which requires the most energy to stay suspended in the water. As the water slows down and the energy level drops, the gravel settles to the bottom of the jar, while the two smaller sediments remain suspended and in motion. As the water continues to slow down, the sand will settle to the bottom. Lastly the soil, which requires the least amount of energy to be moved, will gradually settle on top of the sand.

c) Which of the three sediment types is the least dense?

Density is a measure of how heavy something is compared to its size. If an object is more dense than water, it will sink when placed in water; if it is less dense than water, it will float. Some tiny particles of mud will float or be suspended in the water jar.

d) How does this relate to the badlands?

The larger the particle size, the more energy required to move the particles. A rock made of gravel, such as conglomerate, might be evidence of the components having been moved and deposited by ice sheets or fast-flowing rivers. A medium particle-sized rock, such as sandstone, is evidence of flowing water such as streams. Water without much energy such as a lake or floodplain will accumulate finer particles such as mud and clay, eventually creating the sedimentary rocks shale or mudstone.

Try shaking the jar again but just a little bit. Which, if any, sediments move with a tiny amount of force applied? Gradually increase the amount of energy you are applying to the sealed jar until the largest particles are moving again. Describe what happened. Bones of dinosaurs are more dense than water, therefore they would sink to the bottom of lakes and streams. This allowed them to become buried under consecutive layers of finer sediment and eventually fossilize. This explains why larger fossils are often concentrated along the bottom of the sedimentary layer.