

PALEO SLEUTHS

— DIGGING DEEPER —

PSI – Paleo Sleuth Investigation

Grades 4-8



Paleo Sleuth Investigations, or PSI, includes four activities to be used in succession that focus around fossils in Nebraska and the Ashfall Fossil Beds State Historical Park located north of Royal, Nebraska. Each PSI engages students to explore fossils, the work of paleontologists in discovering, analyzing, and recording fossil evidence, and the environmental conditions of the earth at the time of fossil deposition.

Teacher Background Information

1. Activity length: 2-3 days depending on time needed for research
2. Grades 4-8 can experience this activity. Some extensions for Grades 6 - 8 are noted.
3. This activity uses the 5 E Instructional Model:
 - Engage - create curiosity, access prior knowledge, ask open-ended questions
 - Explore - examine thinking and understanding, test predictions and hypothesis
 - Explain - share possible solutions, explain evidence, develop new understandings
 - Elaborate - add new information and build new explanations, propose solutions
 - Evaluate - answer open-ended questions, demonstrate and communicate understanding
4. This activity uses a science and engineering format found in *A Vision and Plan for Science Teaching and Learning, An Educator's Guide to a Framework for K-12 Science Education, Next Generation Science Standards, and State Science Standards* which involves Gathering, Reasoning, and Communicating.
 - Gathering - defining a problem, asking questions, using models to organize data
 - Reasoning - evaluating data, constructing ideas using math to solve a problem, using evidence as support for or against an explanation
 - Communicating - using written or oral forms to explain how evidence supports the reason
5. The four activities include:
 - **Activity 1 - Are There Fossils in Nebraska? – (Engage)**
 - Read out loud or have students read in groups the paragraph of information at the beginning of Activity 1 titled, "A Story to Share." This draws a connection to Morris Skinner, one of NET's focus paleontologists, who was instrumental in identifying fossils and more importantly the locations of fossils in the layers of rocks and sediments. Students can have short discussions about the collection questions that begin the paragraphs of information to make connections to Morris Skinner and the rest of the activities.
 - PSI teams gather prior knowledge about fossils in Nebraska

- **Activity 2 - What a Fossil Find! - (Explore, Explain)**
 - Students investigate the fossil photo and determine what the photo represents. This photo is of 3-toed horses found at Ashfall to that of present day horses. Students should **NOT** know the photo is of horse fossils until they discover the identity during Activity 4 - Dig Deeper Into Fossil Facts.
 - Copies of Ashfall Fossil Beds Horse Fossil Photo (See attached photo to copy on cardstock)
 - PSI teams:
 - Gather information as they investigate a fossil photo.
 - Use reasoning and evidence to state a claim about what the fossil photo represents.

- **Activity 3 - What Story Can a Mural Tell? - (Elaborate)**
 - PSI teams:
 - Use a mural photo of the location of the Ashfall waterhole to gather more information and questions in their quest to find facts about fossils in Nebraska.
 - Identify the type of environment that existed prior to the ash fall in the mural photo.
 - Build new explanations about the relationships between the fossil and mural photos.

- **Activity 4 - Dig Deeper Into Fossil Facts - (Elaborate, Evaluate)**
 - As a whole class, or in small groups, students watch a video from the Ashfall website that introduces the Ashfall Fossil Beds and Mike Voorhies: *Scarlet Feature - Ashfall Fossil Beds*, under *Plan Your Visit*. Take notes and discuss key points of the video:
 - Mike Voorhies-longest volunteer-point out he is a paleontologist that found a small rhino jaw protruding out of volcanic ash in 1971 along the Verdigre Creek Valley which has now become Ashfall Fossil Beds
 - Ashfall Fossil Beds is a Nebraska State Historical Park.
 - Featured at this site are prehistoric animal skeletons buried in volcanic ash.
 - The volcanic ash fall event occurred 12 mya.
 - Animals met their death in a waterhole.
 - Animal skeletons are preserved in the ash fall.
 - Ashfall gives public a real view of paleontology site being actively excavated.
 - Hubbard Rhino Barn-complete fossils are preserved indoors, climate controlled
 - One place in the world where you can find whole animals preserved
 - No dinosaurs, animals that are mammals lived after the dinosaurs
 - Students, in groups of 4, piece together the fossil story about Ashfall as they research and share facts from the Ashfall Fossil Beds State Historical Park website (<http://ashfall.unl.edu>) and other sources. Each group uses the Jigsaw method to research, where each group member decides on one of the questions to research, then teaches the rest of their group about the facts they found. Each group member will compile all the facts to complete the story about Ashfall.
 - Students will identify the significance of the fossil and mural photos they have examined.
 - Students will identify the reason for fossilization of these animals at the waterhole in Nebraska was the volcanic ash cloud that came from a volcano hot spot in Idaho 12 mya.
 - Students will understand the importance of this State Historical Park today and for future generations.

6. Vocabulary:

- Geology - the study of the physical structure of the Earth and the processes that act on it
- Fossil - the remains or impression of a prehistoric organism preserved in petrified form or as a mold or cast in rock, remains or traces of ancient living things
- Paleontologist - a scientist who works with preserving and studying animal and plant fossils and the traces they leave behind
- Paleontology - is the study of fossils of animals and plants, microorganisms, and the traces they leave behind. Paleontologists study fossils to understand past life forms and changes through time. With the study of fossils, paleontologists can reconstruct the past history of the earth, animals and plants that lived in those times, and the environment that impacted those organisms. They study the evolution and extinction of organisms through the fossil record they encounter.

7. Objectives

Students will:

- Design and conduct investigations that will lead to descriptions of relationships between evidence and explanations
- Use evidence to draw conclusions about fossils
- Describe how environmental conditions have changed through use of the fossil record

The following excerpt was found in - "Fossilization and Adaptation Activities in Paleontology" by Brent H. Breithaupt

"Fossilization is a rare event. The chances of a given individual being preserved in the fossil record are very small. Some organisms, however, have better chances than others because of the composition of their skeletons or where they lived. This also applies to the various parts of organisms. For example, plants and vertebrates (animals with bones) are made up of different parts that can separate after death. The different parts can be transported by currents to different locations and be preserved separately. A fossil toe bone might be found at one place and a fossil rib at another location. We could assume that they are from different animals when, in fact, they came from the same one."

Extension for Grades 6 - 8:

It Was Just Too Hot!

- Students dig deeper as they discover the trail of ash that determined the fate of so many animals and plants at Ashfall.
- Students investigate this phenomena question: **Where did the ash come from?**
 - Students gather evidence using the website resources listed (Paleo Sleuths website - Sites - Ashfall Fossil Beds) to find out:
 1. The cause of the ash.
 2. Where and when this event happened.
 3. How the ash dispersed.
 4. What is a hot spot?
 5. How does a hot spot travel?
 6. Where is the hot spot now?

Extension for Grades 6 -8:

Animals of Ashfall

1. Each student group is given a species of animal found at Ashfall to research.
2. Each group draws the outline of the animal in a life size form on chart paper.
3. Groups research their animal, adding facts inside the outline of the animal and display the animal shape as they share their research with their classmates.

Research facts include:

Name of animal

Example: Slender Three-toed Horse

Scientific name

Example: Neohipparion affine

Description of animal

Example: Slender, 3-toed horse, fast runner, was good at managing rough terrain with 3 toes

What did it eat?

Example: Ate grasses

Size

Example: 4 feet

Other interesting facts

National and State Standards

Next Generation Science Standards

Grade 4 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

- Middle Level MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
- MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

Nebraska State Standards

- Grade 3-5 SC5.1.1 Students will plan and conduct investigations that lead to the development of explanations.
- SC5.1.2 Students will describe how scientists go about their work.
- SC5.1.2.a Recognize that scientific explanations are based on evidence and scientific knowledge
- Grades 6-8 SC8.1.1 Students will design and conduct investigations that will lead to descriptions of relationship between evidence and explanations.
- SC8.1.2 Students will apply the nature of science to their own investigations.
- SC8.1.2.a Recognize science is an ongoing process and the scientific community accepts and uses explanations until they encounter new experimental evidence not matching existing explanations
- SC8.4.4 Students will use evidence to draw conclusions about changes in Earth.
- SC8.4.4.a Recognize that Earth processes we see today are similar to those that occurred in the past (uniformity of processes)
- SC8.4.4.b Describe how environmental conditions have changed through use of the fossil record

Activity Resources

1. Paleo sleuth website: Use the website to research Paleo sleuths, animals, fossil sites and educational resources.
2. NEBRASKAland Magazine's *The Cellars of Time* - Paleontology and Archaeology in Nebraska
3. Ashfall Fossil Beds State Historical Park Website: <http://ashfall.unl.edu>
 - Book: *ASHFALL Fossil Beds* - State Historical Park & National Natural Landmark, Present View of an Ancient Past, found on website: <http://ashfall.unl.edu/>
 - *Ashfall Fossil Beds* Brochure
 - *Ashfall Skeleton Map*
4. PBS Learning Media Library
5. Museum of Paleontology fossil photos <https://umorf.ummp.lsa.umich.edu/wp/>
6. Animal Diversity Web fossil photos <http://animaldiversity.org/>

PSI – Paleo Sleuth Investigations

Activity 1 - Are There Fossils in Nebraska?

Read: A Story to Share

What kinds of collections do you have in your possession? How did you obtain these items? How do you organize your collections? What made you create a collection?

As a teen, Morris Skinner was a collector of fossils. He was so fascinated with fossils that he became a famous fossil hunter, discovering rhino bones that are on display at Nebraska's State Museum, and recognized for his work on fossil collections by the American Museum of Natural History in New York City. But it wasn't just his fossil finds that made him well known, it was the important data he recorded. He took measurements of the locations where he found the fossils, and he drew "rock pictures" about the layers of the earth where the fossils were discovered which became his signature in paleontology. Read more about Morris Skinner on his Paleo Sleuths webpage.

Now it is your turn to go on a fossil hunt as a team of paleontologists. You will work through several activities to uncover hidden secrets about fossils.

Activity 1

PSI teams:

- Gather prior knowledge in this quick activity and share it with your peers.

Are There Fossils in Nebraska? Questions:

- A. What kinds of animals and plants would you find living currently in Nebraska?
- B. What kinds of animals and plants would you find living in Nebraska millions of years ago?
- C. How would an animal or plant become a fossil in Nebraska?
- D. What questions do you have about Nebraska fossil evidence of past animals and plants?

Materials:

Are There Fossils in Nebraska? Worksheet

Student Procedures:

1. Students work in groups of 2-4 as PSI Investigators. **(Explore, Explain)**
2. Groups gather answers to the questions from Are There Fossils in Nebraska?
 - Describe, draw and label answers to the questions. **(Explain)**
3. Groups communicate answers to their questions with their classmates and pose new questions during discussion.
4. The next step in PSI will be Activity 2 - What a Fossil Find!

PSI - Activity 1 - Are There Fossils in Nebraska?

A. What kinds of animals and plants would you find currently living in Nebraska?

B. What kinds of animals and plants would you find living in Nebraska millions of years ago?

C. How would an animal or plant become a fossil in Nebraska?

D. What questions do you have about Nebraska fossil evidence of past animals and plants?

PSI – Paleo Sleuth Investigations

Activity 2 - What a Fossil Find!

Activity 2

PSI teams:

- Gather information as you investigate a fossil photo.
- Use reasoning and evidence to state a claim about what the fossil photo represents.
- Communicate the evidence to support the claim

What a Fossil Find! Questions:

- A. What important facts can you infer from looking at this fossil photo?
- B. What type of animal(s) does this fossil photo represent? Explain.
- C. How would we know if this animal was extinct?
- D. What questions will help you determine what animal(s) these fossils represent?

Materials:

What a Fossil Find! Worksheet
Copies of Fossil Photos

Student Procedures:

Engage:

1. Acquire a cardstock copy of the fossil photo and set of questions from your teacher.



Explore:

2. Gather information to answer questions and discuss your ideas about the fossil photo.

Explain:

3. Use reasoning supported by evidence to decide a claim to explain the fossil photo.
4. Communicate the evidence to support the claim in a class discussion.
5. The next step in PSI will be Activity 3 - What Story Can a Mural Tell?

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Activity 2 - What a Fossil Find!

<p>A. What important facts can you infer from looking at these fossils?</p>	<p>B. What type of animal(s) does this fossil photo represent? Explain.</p>
<p>C. How would we know if this animal was extinct?</p>	<p>D. What questions will help you determine what animal(s) these fossils represent?</p>

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Activity 2 - What a Fossil Find!

Photo courtesy of Ashfall Fossil Beds Website

Make cardstock copies and cut fossil cardstock in half for 2 photos or copy in digital form.



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Activity 3 - What Story Can a Mural Tell?

Activity 3

PSI teams:

- Identify the type of environment that existed in the mural photo.
- Build new explanations with reasons supported by evidence about the relationships between the fossil and mural photos.
- Communicate the evidence to support the claim in a class discussion.

What Story Can a Mural Tell? Questions:

- A. Describe the environment in this mural.
- B. What do you notice about the animals in this mural?
- C. What can you infer about the relationship between the animals and the environment in this mural?
- D. What questions do you have about the relationship between this mural photo and the fossil photo?

Mural Photo courtesy of Ashfall Fossil Beds

Mural by Mark Marcuson



Materials:

What Story Can a Mural Tell? Worksheet

Copies of Mural Photo, preferably on heavy cardstock

Student Procedures:

Engage, Elaborate:

1. Acquire a copy of the mural photo to examine.

Explore

2. Gather information to answer questions and discuss your ideas about the mural photo.
3. Use reasoning supported by evidence to decide a claim to explain the mural photo.

Elaborate:

4. Compare both fossil and mural photos to make connections between the two.
5. Use reasoning supported by evidence to decide a claim to explain how these two photos are related.
6. List any additional questions about these fossil connections.

Explain, Evaluate:

4. Communicate the evidence to support the claim in a class discussion.
5. The next step in PSI will be Activity 4 - Dig Deeper Into Fossil Facts

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Activity 3 - What Story Can a Mural Tell?

<p>A. Describe the environment in this mural.</p>	<p>B. What do you notice about the animals in this mural?</p>
<p>C. What can you infer about the relationship between the animals and the environment in this mural?</p>	<p>D. What questions do you have about the relationship between this mural photo and the fossil photo?</p>

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Activity 3 - What Story Can a Mural Tell?

Mural Photo courtesy of Ashfall Fossil Beds

Mural by Mark Marcuson

Make cardstock copies and cut fossil cardstock in half for 2 photos or copy in digital form.



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Activity 4 - Dig Deeper Into Fossil Facts

Activity 4

PSI teams:

- Jigsaw research and communicate facts about Ashfall Fossil Beds State Historical Park using the website.
- Identify the environment that caused a mass extinction and fossilization of animals.
- Identify the significance of the fossil and mural photos that have been examined and where they are located.

PSI Dig Deeper Into Fossil Facts questions:

- A. Why is this area known as Ashfall Fossil Beds?
- B. What types of animal fossils have been found at Ashfall?
- C. What was significant about the fossil photo you examined from Ashfall?
- D. What was significant about the mural photo you examined from Ashfall?

Materials:

Ashfall Website <http://ashfall.unl.edu/>

Paleo Sleuth Website

Large poster paper

Markers

Double-sided worksheet

Student Procedures:

Engage:

1. As a class, or in small groups:
 - Locate Ashfall Fossil Beds on a map of Nebraska
 - Access the Ashfall Website: <http://ashfall.unl.edu/>
 - Watch the video on the website, *Scarlet Feature - Ashfall Fossil Beds*, under *Plan Your Visit*, Take notes and discuss key points of the video.

Explore:

2. Students, in groups of 4, each receive a double-sided worksheet with 4 PSI Dig Deeper Into Fossil Facts questions.

Explain, Elaborate:

3. Jigsaw Research - Ashfall Fossil Beds: website <http://ashfall.unl.edu/> and Paleo Sleuth website and other sources
 - Each student within each group will research one of the questions using the website
 - Each student will jigsaw or share their information with their other group members until every group member has answers to all 4 questions
 - Students can add questions and other facts to share with their group

Evaluate:

4. PSI teams communicate fossil facts about Ashfall as a class discussion to conclude this activity.

PSI – Paleo Sleuth Investigations
Activity 4 - Dig Deep Into Fossil Facts
Jigsaw Research

A. Why is this area known as Ashfall Fossil Beds?

B. What types of animal fossils have been found at Ashfall?

PSI – Paleo Sleuth Investigations

Activity 4 - Dig Deep Into Fossil Facts

Jigsaw Research

C. What was significant about the fossil photo you examined from Ashfall?

D. What was significant about the mural photo you examined from Ashfall?