Discovering Dinosaurs

Educator's Guide
Grades 5-9

Electronic Field Trip to Grand Staircase-Escalante National Monument and the Museum of Northern Arizona

October 2001

U.S. Department of the Interior
Bureau of Land Management

Copies available from:

Bureau of Land Management
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Share the Adventure!

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Acknowledgments

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The authors would like to express their appreciation to the following people for their assistance:

Laurie Bryant, BLM Utah State Office
Dave Gillette, Museum of Northern Arizona
Merle Graffam, Excavation Team

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Welcome

Dear Educator—

It is our great pleasure to welcome you and your class to the fascinating world of Colorado Plateau dinosaurs! "Share the Adventure! Discovering Dinosaurs" invites students to experience the excitement of scientific inquiry while also learning about its practical applications in paleontology. Our program centers on the excavation of fossils recently discovered in south-central Utah's spectacular Grand Staircase-Escalante National Monument, a vast, untamed area of specially designated public lands under the care of the Bureau of Land Management (BLM).

BLM, an agency of the U.S. Department of the Interior, manages 107 million hectares (264 million acres) of public lands—almost *one-eighth* of the total area of the United States. Located mostly in the Western States and Alaska, BLM lands—which belong to all Americans—host significant natural, cultural, and scientific resources that offer rich educational opportunities. Twenty-five years ago, Congress passed a law (the Federal Land Policy and Management Act) that said BLM lands should belong to all Americans and be available for many uses. That's still our mission today.

We hope that "Share the Adventure!" will be the first of many opportunities for students—regardless of where they live—to "visit" and learn about BLM's unique sites and diverse resources. Our 1-hour, live, interactive satellite broadcast will enable BLM to bring a one-of-a-kind field experience right into classrooms around the nation. And though this experience is intended to be fun and involving, its educational value is our first priority. Each component of the broadcast and the educator's guide supports specific learning objectives that are tied to national education standards.

"Share the Adventure!" features the excavation of hadrosaur tail bones and skin impressions, which are rare fossil finds. The fossils were excavated from public lands in May 2001 as part of a cooperative project between BLM and the Museum of Northern Arizona. During the broadcast, professional paleontologists from BLM and the Museum serve as program hosts and explain the continuing process of scientific inquiry. You and your students will get to see background footage of the excavation and then join the team live at the Museum to study the hadrosaur's tail fossils. Students will have opportunities to test their knowledge and to communicate with paleontologists by telephone or fax. Spirited interaction between students and scientists is definitely encouraged!

Thank you for allowing your students to take part in this special program.

Sincerely,

Nina Rose Hatfield

Nina Rose Hatfield
Acting Director, BLM

An Electronic Field Trip: Bring the World to Your Classroom

An electronic field trip is a distance learning event. It allows students to see and interact with people and environments that are far away at virtually no cost to the school. In this case, the field trip will take students to the remote Kaiparowits Plateau in Grand Staircase-Escalante National Monument in south-central Utah. It also will bring paleontologists at the science labs of the Museum of Northern Arizona in Flagstaff, as well as paleontologists at BLM's National Training Center in Phoenix, Arizona, into the classroom. This is all done through a live satellite television broadcast.

This 60-minute instructional program supports the learning objectives and national education standards outlined below. While geared for the middle school student, the broadcast should be of educational value and interest to students at all levels of learning. Question and answer periods will provide students with the opportunity to interact with paleontologists during the live broadcast via phone and fax.

Learning Objectives

During this broadcast, you and your students will learn about:

- The process of scientific inquiry and how it is used by paleontologists.
- Fossils—how they form and what we can learn from them.
- Scientific values of Grand Staircase-Escalante National Monument and other protected areas on public lands.
- Actions you can take to protect scientific resources on public lands.
- Your part ownership of America's public lands.

National Education Standards

The broadcast and the materials in this guide align with the following National Science Education Standards for grades 5-9:

Standard A. Science as Inquiry: Abilities necessary to do scientific inquiry; understanding about scientific inquiry.

Standard C. Life Science: Biological evolution; diversity and adaptations of organisms.

Standard D. Earth and Space Science: Structure of the Earth system; Earth's history; origin and evolution of the Earth system.

Standard G. History and Nature of Science: Science as a human endeavor.

How to Use This Guide

This guide includes several suggested readings and activities for you and your students to do before and after the broadcast. The readings are primarily designed to give students some contextual background before the broadcast. Depending on the reading level of your students, you may want to make copies of these pages to hand out, read them aloud, or read them in advance and summarize the contents for your students. The suggested activities provide you with a variety of ways to enhance the learning experience in the classroom. Most are designed as hands-on activities, but they could also be performed as demonstrations. Some can be accomplished easily within the class period, while others involve more time. We encourage you to choose activities that match your students' interests and abilities and complement your lesson plans.

The guide also includes an evaluation form. Please be sure to complete the form and return it to us. This will help us design future programs targeted to your needs. The first 100 educators to complete and return the evaluation form will receive "Share the Adventure!" t-shirts.

Share the Adventure: Tips and Technology

Date

Thursday, October 25, 2001

The program will be broadcast twice to accommodate schools across the country (see broadcast times on page 6).

How to Participate in the Program

Anyone with a C-band satellite dish can participate in the program. You will need access to the satellite receiver, a monitor, and—if you want to tape the show for future use—a videotape recorder. There are no restrictions on rebroadcasting. For interactive participation, you will need either a phone or fax machine.

If You Don't Have a Satellite Dish

Many cable companies, school systems, school districts, district or regional media centers, or State educational television stations have access to a C-band satellite dish and may be able to provide your classroom with the program through an internal cable channel. Check with them early. You will need to provide the satellite coordinates listed on page 6.

Television Receiver

Plan your setup before the day of the event. Check the technical information page for the satellite coordinates. Tune in the satellite and make sure you can receive the satellite listed. Check to see that all other equipment is working properly. You may want to use more than one television depending on the number of viewers. For large groups, a projection TV is recommended.

Plan to Interact with Us

Make sure you are ready to participate via phone or fax. Check all equipment the day before the event. Place the phone in the back of the room away from the TV. An operator will answer your phone call. When the operator indicates that you are live on the air, turn your television volume down to avoid feedback. Wait for the host to ask for your question. Make each question as clear and brief as possible, and ask one question at a time.

Review "Meet The Players" and Other Background Material

Copy and distribute the "Meet the Players" section of this guide so students can learn who is who. Have your students do some of the preparatory activities included in this guidebook. Decide as a class what are the most important questions to ask and to whom they will be directed. Encourage students to ask questions that pertain to this particular specimen or project.

Visit Our Web Site

This guide, an evaluation form, and additional information on BLM's education programs are available on our Web site at *http://www.blm.gov/education*. This site also includes hot links to other Web resources, including the Web site of the Museum of Northern Arizona.

Videotaping the Broadcast

If you are unable to view the live broadcast, we encourage you to tape and use the program in future lessons. You may also rebroadcast this program over the school cable system. We will have a limited number of copies available for schools that are unable to tape the broadcast. Contact us through our Web site (*http://www.blm.gov/education/00_fieldtrip/index.html*) to obtain a copy.

Satellite Coordinates

Transmission Type	Satellite	Orbital Location	Transponder	Polarity	Downlink Frequency
C-Band	Galaxy-3	95 Degrees W	2	Vertical	3740 MHz

Satellite help hotline for help with reception problems (day of broadcast only): 1-602-906-5629

Broadcast Times

Telecast #1 Time Zone	Test Signal	Program Starts	Program Ends
Alaska Time	6:30 am	7:00 am	8:00 am
Pacific Time	7:30 am	8:00 am	9:00 am
Mountain Time	8:30 am	9:00 am	10:00 am
Central Time	9:30 am	10:00 am	11:00 am
Eastern Time	10:30 am	11:00 am	12:00 noon

Telecast # 2 Time Zone	Test Signal	Program Starts	Program Ends
Alaska Time	9:30 am	10:00 am	11:00 am
Pacific Time	10:30 am	11:00 am	12:00 noon
Mountain Time	11:30 am	12:00 noon	1:00 pm
Central Time	12:30 pm	1:00 pm	2:00 pm
Eastern Time	1:30 pm	2:00 pm	3:00 pm

Please note: Occasionally, last minute changes may occur in satellite coordinates or broadcast times. Please check the following Web site for updated information:

http://www.ntc.blm.gov/coming_events/ce-205.html

Interactivity

During the telecast, students may phone in questions toll-free:

Call-In Number: 1-877-862-5346 (for everyone outside the Phoenix area)
Greater Phoenix Area: 602-943-2279

Student questions will also be accepted by fax (caller pays):

Fax Numbers: 1-602-906-5701 and 1-602-906-5702

Meet the Players!

In Phoenix

Chip Calamaio is an executive producer and cohost of the program. He manages the BLM National Training Center's video operations in Phoenix, Arizona, as well as the BLM Satellite Network. He has more than 30 years of experience in instructional television and distance learning and has worked with the Bureau of Indian Affairs and the University of New Mexico. Since 1985, he has specialized in natural resources media production with BLM and has traveled throughout the West producing instructional television projects in all BLM program areas.

Alan Titus is a BLM paleontologist who has been working at Grand Staircase-Escalante National Monument for 2 years. He studied at the University of Nevada at Las Vegas (B.S.), University of Arkansas (M.S.), and Washington State University (Ph.D.), and has held several teaching positions at colleges and universities in the West. Born in Toledo, Ohio, and raised in Las Vegas, Dr. Titus has been interested in paleontology since childhood. As a young boy, he spent countless hours outside the city of Las Vegas, Nevada, exploring fossils in the ancient rocks.

Laurie Bryant is the regional paleontologist in BLM's Utah State Office in Salt Lake City. She studied at Occidental College (B.A.) in Los Angeles, California, the South Dakota School of Mines and Technology (M.S.), and the University of California at Berkeley (Ph.D.). She worked as a museum collections manager, college professor, and consultant before joining the BLM in 1992. Dr. Bryant narrowed down her career choice at an early age. She still has the fossil clams she collected from roadcuts in the Santa Monica Mountains when she was 8 years old.

In Flagstaff

David Gillette is the Colbert Curator of Paleontology at the Museum of Northern Arizona in Flagstaff. Dr. Gillette received his B.S. in biology from Michigan State University and Ph.D. in geology from Southern Methodist University. His interest in paleontology bloomed during college while working as a field assistant in the summer. He has 34 years in the field and has authored numerous publications, including the popular book, *Seismosaurus: The Earth Shaker*.

Barry Albright has worked as a curator of geology and paleontology at the Museum of Northern Arizona for 2 years. He received his Ph.D. in 1997 from the University of California at Riverside. His interest in paleontology goes back to his childhood days in Charleston, South Carolina, where he spent many afternoons walking along the riverbanks with his grandfather looking for fossils. He also spent time in graduate school on an expedition to Antarctica looking for Australian ancestral marsupials.

Student Hosts

Savanna Davenport is a student at Kanab High School in southern Utah. She will cohost the show from BLM's National Training Center in Phoenix.

Cody Brunner, Malena Grosz, and Katie Stirland are also students at Kanab High School in southern Utah. They will cohost the show from Flagstaff.

In the Audience

You! Yes, you could one day make an important fossil discovery, even if you do not become a paleontologist. Many important fossil discoveries are made by amateurs—students and adults alike. If you do make a discovery, be sure you know the rules of fossil collecting. These are outlined on page 52. If you become a paleontologist, you will have many opportunities for discovery all over the world. In fact, many important discoveries remain to be made right on the Kaiparowits Plateau, where we'll take you during our satellite broadcast.

Behind the Scenes

It takes a lot of talented people to put together a broadcast. Here are a few of the many major players "behind the scenes":

- Marietta Eaton served as an advisor. She is the assistant monument manager at Grand Staircase-Escalante National Monument in south-central Utah, specializing in cultural and geological resources.
- Art Ferraro is directing the broadcast. He is a senior producer/director with BLM's National Training Center.
- Kevin Flynn, the web editor for BLM's Environmental Education and Volunteers Office in Washington, DC, coordinates all Web-related programs for this show.
- Merle Graffam served on the excavation team as a field paleontologist.
- Alma Lively is producing the remote segment of the broadcast from Flagstaff. She is a producer/director at BLM's National Training Center in Phoenix.
- Elizabeth Rieben is producing the broadcast. She is an education specialist and writer for BLM's Environmental Education and Volunteers Office in Washington, DC.
- Kelly Rigby, a photographer from BLM's Utah State Office, helped document the excavation.
- Mary Tisdale is an executive producer of the show. She manages BLM's Environmental Education and Volunteers Office in Washington, DC.
- Betsy Wooster, education specialist in BLM's Environmental Education and Volunteers Office in Washington, DC, coordinated the production of the activity book.

Paleontologists: Unraveling the Stories of Ancient Life

Many of the people you will meet in the broadcast are paleontologists. But what exactly does a paleontologist do? A paleontologist is a scientist who studies ancient forms of life primarily through the study of fossils. This scientist often has a background in biology and geology as well as paleontology. Paleontologists use math, biology, and even engineering to wrestle with getting heavy bones out of the ground. They use drawing skills to create detailed site maps. They use computer models, satellite images, CAT scans, radar images, and other technical data and methods. Paleontologists also need to be able to write well to let other people know about their discoveries and research.

There are many specialized areas of study. Can you guess what these specialists study?

- paleoecologist
- paleozoologist
- paleobotanist
- paleobiogeographer

A Paleontologist Is <u>Not</u> an Archaeologist

Many people confuse the terms paleontologist and archaeologist. A paleontologist is not an archaeologist. A paleontologist studies life of past geological periods through fossils, which are the remains and traces of once-living organisms preserved in the rocks of the Earth's crust. An archaeologist studies evidence of past human activity, such as ruins of buildings, pottery, and skeletons. Both paleontologists and archaeologists study clues to the past, but they focus on different things. For instance, if a mammoth skeleton is found with spear points made by humans, both groups of scientists would be involved. The archaeologist would focus on the humans who killed the mammoth. The paleontologist would focus on identifying the mammoth and learning about its environment.

Activity

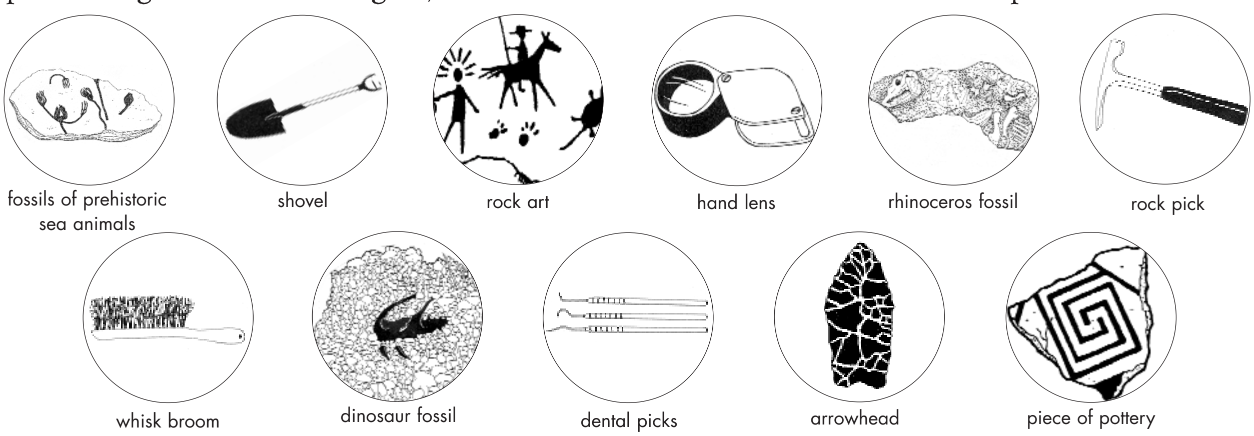
Paleontology and Archaeology

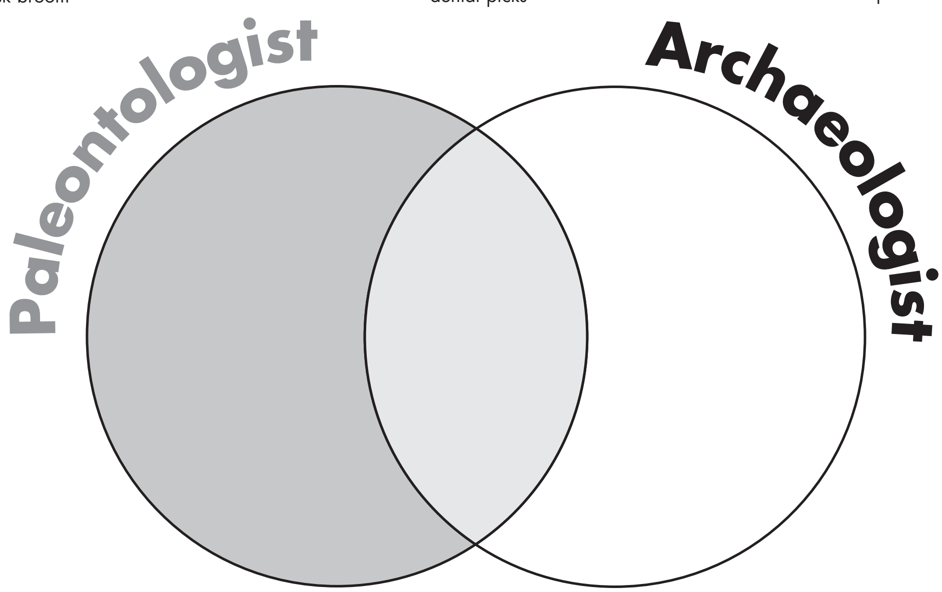
Objective

To compare and contrast the sciences of paleontology and archaeology.

Below are some pictures of objects that would be of interest to a paleontologist, an archaeologist, or both. The objects include not only relics from the past (from human history and before), but also tools used by scientists in uncovering these clues.

Below the pictures are two overlapping circles. Draw a line from each object that would be of interest to paleontologists to the circle labeled "Paleontologist." Draw a line from each object that would be of interest to archaeologists to the circle labeled "Archaeologist." If an object is of interest to both paleontologists and archaeologists, draw a line to the area where the circles overlap.





Discovery: The Hadrosaur Tail Fossil

Science is an adventure. Scientists are always asking questions and learning new things. Sometimes scientists work in laboratories; sometimes they work out in the field. Sometimes scientists do research in libraries, and sometimes they make important discoveries that make front page news. But even when they don't, scientists are always part of an adventure—learning about our world. Here's the story of one adventure that you can take part in too.

In 1998, Dr. Alan Titus, paleontologist at Grand Staircase-Escalante National Monument in Utah, was conducting fossil inventories on the Kaiparowits Plateau. In an area of exposed rock, he came upon three vertebrae—bones that form the backbone of an animal. He found other bone fragments as well, but what made this discovery remarkable was the fact that the vertebrae were still "articulated," or joined together. In addition, many of the tendons that held the skeleton together in life were also preserved. They had hardened into bone (become "ossified") while the dinosaur was still alive. Fossilized tendons are not common. The skeleton and tendons were found in a small wash—a low-lying area that only has water in it when it rains.

Dr. Titus and Dr. David Gillette from the Museum of Northern Arizona studied this specimen in the ground and suspected that it belonged to the family of dinosaurs known as hadrosaurs, or duck-billed dinosaurs. They thought it could provide important information about hadrosaurs of the Kaiparowits Plateau. They also believed that, with further study, they might be able to identify the genus and species of this animal.

Excavating the Fossil

Studying a fossil is almost like investigating a crime scene. Before they move any evidence, paleontologists need to carefully observe the area where the fossil is located and to prepare detailed field notes based on their observations (see p. 12). This enables them to collect clues about the surrounding rock layers and other important information.

A portion of the hadrosaur fossil was exposed on the surface, subjecting it to weathering and to vandalism. To protect the specimen and to study it fully, the Museum of Northern Arizona and BLM paleontologists decided to excavate the bones. This turned out to be a very slow, painstaking process due to the very hard rock that surrounded the specimen. It took about 5 weeks to dig it all out of the ground. This excavation was documented during May 2001. (A journal about this excavation can be found on BLM's Web site at *http://www.blm.gov/education/00_fieldtrip/journal.html.*)

During this excavation, the paleontologists came to realize that much of the skeleton was missing. They suspect that water in the wash carried pieces of the skeleton away from the site and destroyed

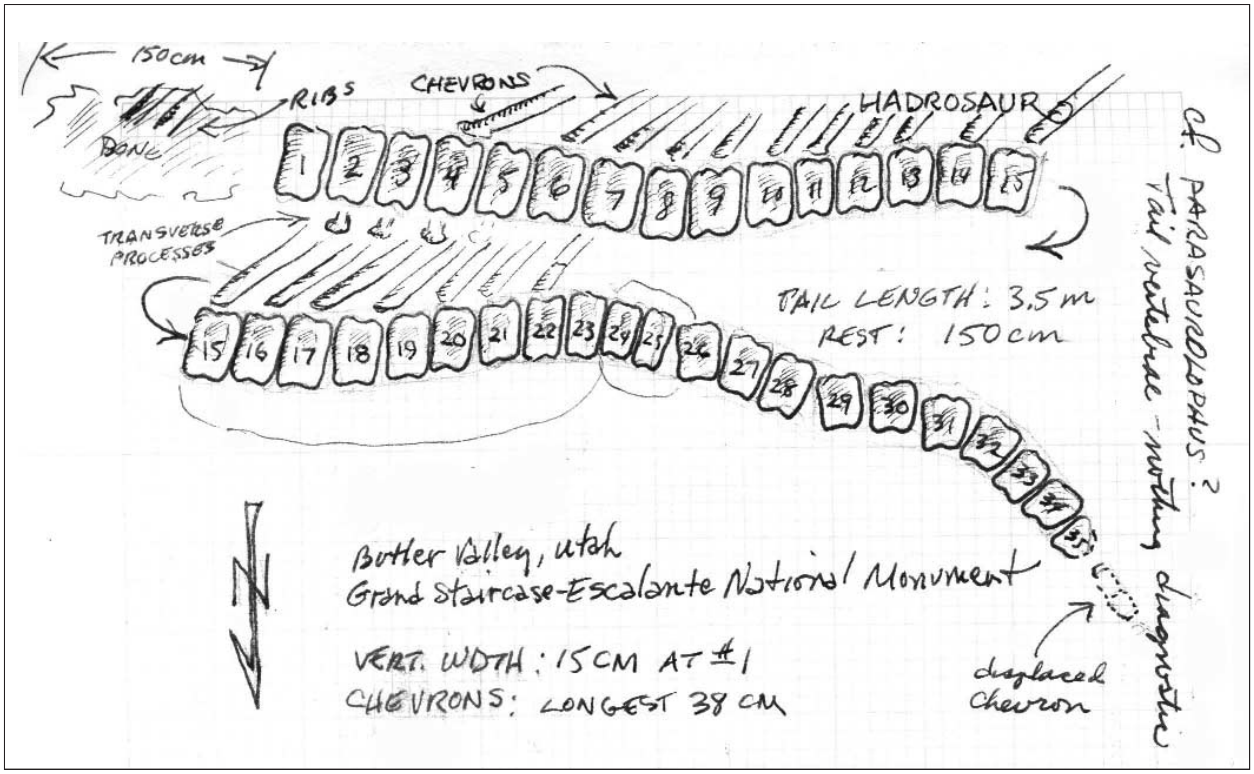


Illustration courtesy of Merle Graffam and the Museum of Northern Arizona.

From Observation to Publication

Excavating fossils from the surrounding rock is just part of a paleontologist's work. Detailed field notes, based on careful observation and measurements, provide important data once the specimen is removed from the ground. Not all paleontologists are good artists, but it helps to be able to draw. The team at Grand Staircase-Escalante particularly values Merle Graffam's ability to make accurate sketches in the field. A page from Mr. Graffam's field notebook is reproduced here. Each of the vertebrae was numbered while the bones were still locked in the rock at the site. Paleontologists use the numbers for reassembly in the lab and for referencing in their notes.

Other bones were also numbered in additional drawings. The bones labeled "chevrons" form at the underside of the tail, and the "transverse processes" are bones that stick out on either side of the vertebrae. Both these sets of bones are very long in this specimen, one clue that led the paleontologists to conclude that they were dealing with a hadrosaur, and perhaps a *Parasaurolophus*. That is just one answer that the scientists hope to find with further research.

The paleontologists will use the field notes made by Merle Graffam and several others on the excavation team to produce articles and a finished map of the site, which will be published in scientific journals. However, the field notes will remain as part of the collection at the Museum of Northern Arizona, along with the skeleton, for other researchers to study.

them. And on May 16, the paleontologists made a startling discovery. In addition to the bones and tendons, they found skin impressions from the sides of the tail. This is only the second time dinosaur skin impressions have been found in Utah; in fact, only about two dozen have ever been found anywhere in the world.

The excavation crew carefully jacketed the bones, tendons, and skin impressions, which means wrapping them in burlap and plaster to protect them. The next step was to take the fossils to the Museum of Northern Arizona, where they could investigate them fully. As you will see in the broadcast, the discovery of the hadrosaur tail skeleton was just the beginning of a long process of discovery.

What Makes This Discovery Important?

Many significant dinosaur fossils have been found in Utah. But little is known about the Cretaceous period there—the period that lasted from 136 to 65 million years ago, when dinosaurs became extinct. Cretaceous-age dinosaurs are probably quite common in Utah, but few paleontologists have explored there for dinosaurs from that period. Grand Staircase-Escalante National Monument has already shown signs that it contains a remarkable record of dinosaurs and other animals from this period. However, so far, very few sites are known, mostly because paleontologists have only recently begun to explore in this remote area.

The hadrosaur fossil found at Grand Staircase-Escalante was found in rocks from the late part of the Late Cretaceous period, a stage scientists call the Campanian stage. The fossil represents one of the first (and definitely the best preserved) of what is hoped will be a large number of scientifically important specimens. As more are discovered and studied, they may help tell the story of what happened at the end of the Cretaceous period when all dinosaurs became extinct. (Several new discoveries have been made in the monument since this one was documented. Tune in to the broadcast to learn more!)

Questions and More Questions

We already know a few things about the hadrosaur fossil at Grand Staircase-Escalante. For one thing, the tail, hips, and left leg are perfectly articulated (joined together). The bone is real bone. It has not been replaced by minerals like silica or calcium carbonate. The bones were buried in the sand bar of a river that flowed 75 million years ago. Large areas of skin impressions were also discovered. Numerous plant fossils, including what could be a *Sequoia* branch, were found mixed with the skeleton. Other fossils have been found nearby, including the toe and tail bones of small *Velociraptor*-type dinosaurs, crocodile back plates, a tooth of a large meat-eating dinosaur, fish scales, turtle shells, clams, and petrified wood.

While paleontologists have answered some questions, they hope to answer many more with this specimen. Here are just a few:

- Where is the rest of the animal? The tail is so perfectly preserved that it is almost certain the entire fossil of the animal was there originally.
- What genus and species is it? The scientists have made a preliminary identification of the specimen as belonging to the family of hadrosaurs. But much can still be learned about it by comparing the bones of this fossil to the bones of other similar forms found elsewhere. Perhaps the genus and species can be determined.
- What did it look like? The rare skin impressions will help paint a picture of what this animal looked like “in the flesh.” Skin impressions do not suggest color, but they do show texture.
- How did it die? Because the skeleton was fully articulated, the specimen must have been buried in the river sands very quickly, with much of the flesh and skin still on it. This means it probably wasn’t exposed long enough to become a meal for numerous scavengers or predators that would have torn the bones apart.
- How old was the animal when it died? The size of the skeleton is somewhat small compared to other hadrosaur specimens found elsewhere. This may indicate that it was not fully grown, but it may also indicate that the animal was a smaller species found only in Utah. Study of the bones may help show whether it had finished growing or not.
- What kind of environment did this animal inhabit and with what other species did it interact? We have many clues to tell us about the environment in which this hadrosaur lived, such as plant fossils, other bones found nearby, and structures found in the rocks themselves. Because the specimen is so well-preserved, it is not likely that it was transported by currents or otherwise moved to the location where it was found. It probably was buried very close to where it actually lived. More study is needed to piece the various clues together and reconstruct the animal’s habitat.

During the broadcast, you will see how the paleontologists go about trying to answer these and other questions. They make observations, develop and test hypotheses, and try to decide on the most promising explanations for what they have observed. They conduct research, make more observations, and, almost certainly, ask even more questions.

What else would *you* like to know about the dinosaur fossil at Grand Staircase-Escalante?
During the broadcast, you will have an opportunity to talk to the paleontologists who are studying this fossil at the paleontology labs of the Museum of Northern Arizona. They may be able to answer some of your questions.

Activity

Observation and Inference

Objective

To distinguish between observation and inference.

Science is based on observation and inference. Observation is not just seeing. It may involve measuring with instruments, hearing, touching, and otherwise noting the facts of something occurring. An inference is an assumption based on observation. A hypothesis is an inference that a scientist attempts to confirm or disprove through testing. By making observations and inferences, formulating hypotheses and then testing them, paleontologists develop conclusions about what the past was like. As new observations are made and new hypotheses tested, conclusions are changed, corrected, and improved.

Based on observations about the dinosaur fossil seen in the broadcast, the paleontologists from Grand Staircase-Escalante and the Museum of Northern Arizona infer many things about this particular dinosaur, about dinosaurs in general, and about the ancient environment in which dinosaurs lived.

It is important for students to be able to distinguish between observation and inference. Present your students with a possible observation-inference scenario from their lives. For example, all the students in the classroom who ate in the cafeteria on Tuesday were sick on Wednesday (observation). What many and varied reasons (proposed inferences) might there be for this illness? Some possible answers might be food poisoning, a virus, or a student protest. In what ways might one or more of these inferences be tested in order to come to a conclusion about the cause of the illness? Some examples might be to send all the students to the school nurse for examination, test the food from Tuesday, obtain a medical history from the parents of each student, or interview the students.

Make copies (double-sided, if possible) of the illustration and statements on pages 16 and 17 and distribute to each student or team of students. They will determine whether each statement is an observation or an inference. Observations should be marked with the letter "O" and inferences with the letter "I." Later, go over their answers as a group, discussing the logic used in making their choices. (See page 18 for correct answers.)

Extension

During the broadcast, challenge your students to note at least three observations they make. When the broadcast is over, have them suggest at least one inference they can make from each of these observations. How would they go about testing their inferences?

Copy Page

Once Upon a Time

A time machine has been invented that travels into the past and takes pictures, sending them to the present. Here is one of the pictures. You are asked to look at it and interpret what you see. Then, read the statements on the next page. Put an "O" before the statements that are observations and an "I" before the statements that are inferences.

1. ___ The volcano is erupting.

2. ___ The *Allosaurus* is going to eat the *Stegosaurus*.

3. ___ The *Stegosaurus* will run into the water to escape.

4. ___ The *Allosaurus* is leaving tracks on the ground.

5. ___ The ground where the *Allosaurus* is walking is wet.

6. ___ There are plants growing in the water.

7. ___ The *Allosaurus* is going into the water to eat the plants.

8. ___ There is a tree growing next to the river.

9. ___ The tree looks like a palm tree.

10. ___ The climate is warm.

11. ___ The *Stegosaurus* is eating the plant.

12. ___ The *Stegosaurus* is an herbivore.

13. ___ There are bones from a dead animal by the shore.

14. ___ The *Allosaurus* killed the animal.

15. ___ There is at least one more animal in the water.

16. ___ The *Allosaurus* can't swim and will drown.

17. ___ Lava is coming down the sides of the volcano.

18. ___ The *Allosaurus* has sharp teeth.

Answers to Activity

1. O
2. I
3. I
4. O
5. I
6. O
7. I
8. O
9. O
10. I
11. I
12. I
13. O
14. I
15. O
16. I
17. O
18. O

Welcome to Grand Staircase-Escalante National Monument!

Imagine the most remote place in the continental United States—the last place to be mapped. A place where there are few trails...and fewer roads. Little water, less shade, and no bathrooms.

You can walk for hours and see no one. But you are not alone. You can see thousand-year-old pinyon and juniper trees, prehistoric dwellings, ancient rock art, and amphibians, birds, mammals, and reptiles. If you look very carefully, you can even see dinosaur tracks—one sign that this was a vastly different place millions of years ago. Today, you can look down into brightly colored canyons and crevices. Brilliant cliffs and plateaus tower over your head, as do hoodoos—those odd-shaped rock columns created by erosion.

What is this magical place? It's Grand Staircase-Escalante National Monument in south-central Utah. Located on the Colorado Plateau, the monument is a dramatic desert landscape, rich in natural and human history and fossils of all kinds. It covers almost 770,000 hectares (1.9 million acres) of Utah's public lands managed by the Bureau of Land Management. That's larger than the State of Delaware!

The monument is divided into three regions:

1. The Grand Staircase. This has been called a museum of Earth history because it is a series of great geological steps that climb northward across the southwest corner of the monument. The Chocolate, Vermilion, White, Gray, and Pink Cliffs span five different life zones, distinct regions with characteristic plants and animals. From low-lying desert to coniferous forest, this area is a masterpiece of biological, as well as geological, diversity.

2. The Kaiparowits Plateau. The hadrosaur (duck-billed dinosaur) featured in this broadcast was discovered here. The plateau is a vast, wedge-shaped block of mesas and deeply incised canyons. It towers above the surrounding canyonlands. The isolated, rugged plateau, a refuge for wildlife and rare plants, also contains numerous archaeological and fossil resources.

3. Canyons of the Escalante. Here, the Escalante River and its tributaries wind through a 1,600-km (1,000-mile) maze of canyons. This magical labyrinth is one of the scenic wonders of the West.

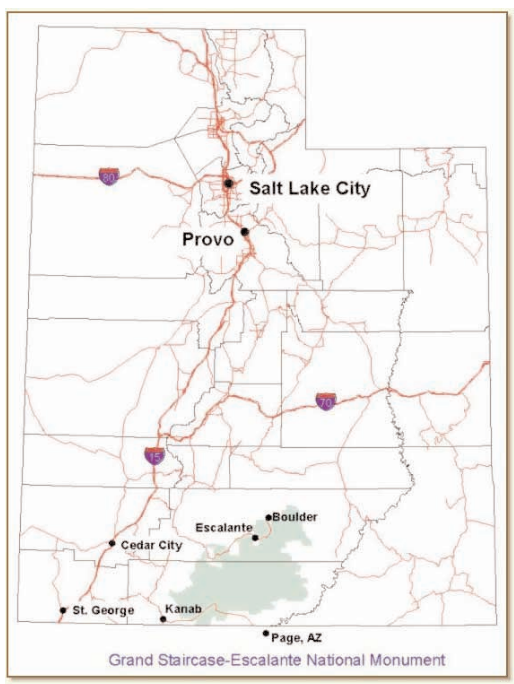
The Kaiparowits Plateau gets top billing in this program. In this desolate outback, untold numbers of fossils lie buried. It takes patience, strength, and endurance to uncover the prehistoric riches of this rugged and unforgiving landscape. But for scientists and others who want to learn about our planet's past, the effort is certainly worthwhile.

From Lush Tropics to Arid Desert

Grand Staircase-Escalante National Monument was not always a desolate and arid place. Instead of canyons and mountains, a low-lying, flat coastline and lush tropical vegetation existed at the time this dinosaur roamed the area. Most all of the plant fossils identified from this period are tropical to subtropical species that inhabit wet forests. Animal fossils, including clams, snails, amphibians, reptiles, crocodiles, and small mammals, also indicate a wet, lush environment with rivers and thick forests. At least 10 different kinds of dinosaurs have been identified from this area as well.

Some 70 million years ago, the dinosaur featured in the broadcast apparently died and fell into a river, where it was rapidly buried. Tons of mud, silt, and sand were deposited, layer upon layer, over millions of years. These layers of sediment turned to solid rock, while patches of swampy vegetation turned into coal. The dinosaur skeleton lay deeply buried as it slowly fossilized.

In more recent times—8 million years ago—shifting in the Earth's plates caused a large area in the western United States to rise. As it lifted up, erosive forces of wind and water began to cut deep canyons, exposing previously hidden layers of rock. About 1,000 years ago, the rock was stripped off to where the hadrosaur lay, probably exposing its skull first. As erosion continued, the skull, neck, and shoulders were probably lost.



Activity

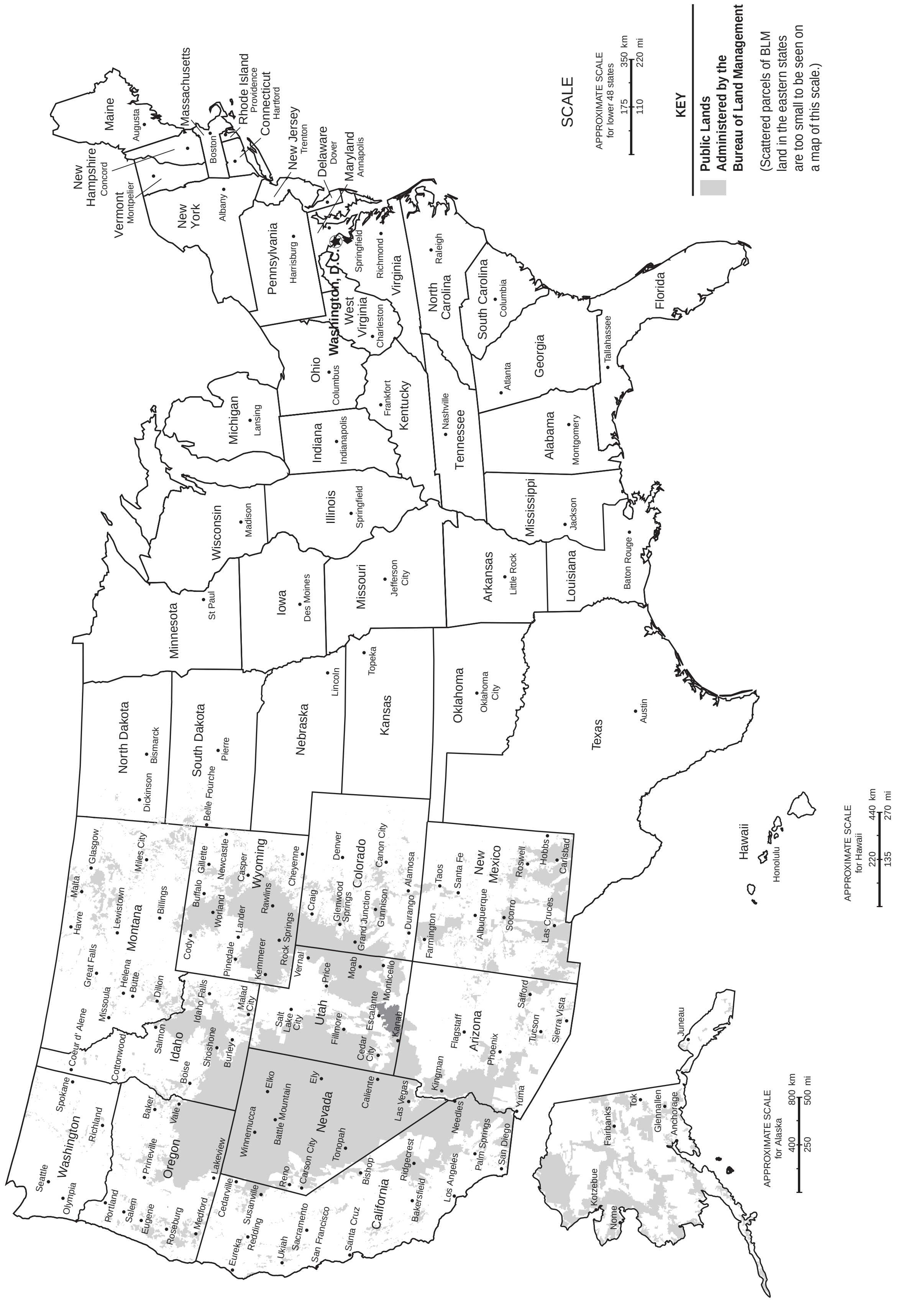
Where Are We?

Objective

To locate Grand Staircase-Escalante National Monument, as well as Phoenix and Flagstaff, Arizona, on a map.

Have your students look at the map of the United States on the next page. See if they can locate Grand Staircase-Escalante National Monument. First have them find where Colorado, Arizona, Utah, and New Mexico meet—this is called the “Four Corners” region. The monument is to the west of this, in southern Utah. Can they find the town of Kanab? That is to the south of Grand Staircase-Escalante National Monument. Next have them find Phoenix on the map. Between the monument and Phoenix, they should then be able to locate Flagstaff. This is where the Museum of Northern Arizona is located.

Using the map scale, have your students estimate the distance from their home to the Four Corners region of the United States.


SCALE
APPROXIMATE SCALE for lower 48 states
175 350 km
110 220 mi
KEY
Public Lands Administered by the Bureau of Land Management
(Scattered parcels of BLM land in the eastern states are too small to be seen on a map of this scale.)
APPROXIMATE SCALE for Hawaii
220 440 km
135 270 mi
APPROXIMATE SCALE for Alaska
400 800 km
250 500 mi
Washington, D.C.
Maine
Augusta
New Hampshire
Concord
Vermont
Montpelier
Massachusetts
Boston
Rhode Island
Providence
Connecticut
Hartford
New York
Albany
New Jersey
Trenton
Delaware
Dover
Maryland
Annapolis
Pennsylvania
Harrisburg
West Virginia
Charleston
Virginia
Richmond
Springfield
North Carolina
Raleigh
South Carolina
Columbia
Georgia
Atlanta
Florida
Tallahassee
Ohio
Columbus
Michigan
Lansing
Indiana
Indianapolis
Kentucky
Frankfort
Tennessee
Nashville
Alabama
Montgomery
Mississippi
Jackson
Louisiana
Baton Rouge
Illinois
Springfield
Wisconsin
Madison
Minnesota
St Paul
Iowa
Des Moines
Missouri
Jefferson City
Arkansas
Little Rock
Texas
Austin
Oklahoma
Oklahoma City
Kansas
Topeka
Nebraska
Lincoln
South Dakota
Pierre
Belle Fourche
North Dakota
Bismarck
Dickinson
Montana
Glasgow
Malta
Havre
Miles City
Lewistown
Billings
Great Falls
Helena
Butte
Missoula
Dillon
Wyoming
Gillette
Newcastle
Buffalo
Casper
Worland
Cheyenne
Rawlins
Lander
Cody
Pinedale
Kemmerer
Rock Springs
Colorado
Denver
Canon City
Craig
Glenwood Springs
Grand Junction
Gunnison
Alamosa
Durango
New Mexico
Taos
Santa Fe
Roswell
Hobbs
Carlsbad
Albuquerque
Socorro
Farmington
Las Cruces
Utah
Vernal
Price
Moab
Monticello
Salt Lake City
Fillmore
Escalante
Kanab
Cedar City
Arizona
Flagstaff
Safford
Phoenix
Tucson
Sierra Vista
Kingman
Yuma
Idaho
Idaho Falls
Malad City
Salmon
Shoshone
Burley
Boise
Cottonwood
Coeur d' Alene
Nevada
Elko
Ely
Battle Mountain
Winnemucca
Caliente
Las Vegas
Tonopah
Carson City
Reno
Washington
Spokane
Richland
Seattle
Olympia
Oregon
Baker
Vale
Prineville
Lakeview
Portland
Salem
Eugene
Roseburg
Medford
California
Cedarville
Susanville
Eureka
Redding
Ukiah
Sacramento
San Francisco
Santa Cruz
Bishop
Ridgecrest
Bakersfield
Los Angeles
Needles
Palm Springs
San Diego
Hawaii
Honolulu
Juneau
Tok
Fairbanks
Glennallen
Anchorage
Kotzebue
Nome

Activity

From Sediment to Rock to Sediment Again

Objective

To demonstrate the geological processes of deposition, layering (sorting), cementation, and weathering.

When watching the video filmed at Grand Staircase-Escalante, your students will probably notice the well-defined layers of rock that characterize much of the Colorado Plateau. Such layering is typical of sedimentary rocks. Most of the rocks exposed at the Earth's surface—more than 70 percent, in fact—are sedimentary, composed of deposits of sand, silt, or clay, often sorted into neat, homogeneous layers. But how are loose, mixed-up sediments actually transformed into the massive, layered accumulations of rock we see in Grand Staircase-Escalante National Monument?

After sediments are deposited, the processes of compaction and cementation cause the particles to form rock, or lithify. In the monument—and throughout the Colorado Plateau—sediments were compressed under their own weight and then cemented by dissolved substances, such as calcium carbonate, to form sedimentary rock. Erosional forces, such as water and wind, constantly work to wear down rock, creating loose sediments that may one day form new rock.

In the following activities, your students can demonstrate the processes of deposition, layering (sorting), cementation, and weathering. (Note: While these activities can be conducted as demonstrations, they work best with students working in small groups of three or four individuals.)

Materials

- sand (300 mL per student group)
- gravel (90 mL per group)
- water
- small plastic dinosaur model (less than 5 cm long)
- 1-L jars with lids (one per group)
- nontoxic white glue
- 150- to 210-mL paper cups (two per group)
- small-diameter ring stands (one per group)
- small bowls (one per group)

Procedures

Deposition/Sorting Activity

1. Give each group a jar that is approximately half-full of water. Also give each group two separate quantities—120 mL and 60 mL—of a 50:50 sand/gravel mixture.
2. Instruct students to add 120 mL of the mixture to the jar, place the lid on the jar, shake it *gently*, and then let it stand for 10 minutes.
3. During the waiting time, have students predict how the sediments will settle.
4. After the 10-minute waiting period, have the students add the remaining 60 mL of the sand/gravel mixture to the jar *without shaking the jar.*
5. Have students record their observations.

Cementation Activity

1. Prepare a 50:50 glue/water mixture ahead of time.
2. Position a ring stand above a bowl.
3. Poke small holes in the bottom of a paper cup, so that the glue mixture will be able to pass through the holes but the sand will not.
4. Pour sand into one of the perforated cups until it is about half-full. Place the plastic dinosaur on top of the sand. Then finish filling the cup with the sand.
5. Have students suspend the cup in the ring stand above the bowl.
6. Students should then gradually pour the cup full of the glue mixture into the sand-filled cup.
7. Allow the glue to drain through the sand for several days.
8. After the glued sand has dried, direct the students to tear away the paper cups to view their "rocks."
9. Ask students to explain how their sand blocks are similar to sedimentary rocks seen in the video. Can they see any signs of the dinosaur?

Weathering Activities

Have students describe changes in their “sandstone” after it is subjected to various forms of artificial weathering:

- Place a sample in a sink and allow tap water to drip on it overnight.
- Place a sample under direct lamplight for 2 weeks.
- Place a sample in a freezer for a month.
- Alternate a sample between the lamp and freezer (weekly for a month).
- Place a sample outside where it will be exposed to natural weather conditions and make weekly observations during the semester.

Conclusion

Though the timeframes for these activities are greatly compressed relative to those of natural geologic processes, your students will nevertheless gain a hands-on understanding of the mechanisms that transform loose sediments into sedimentary rock and back into loose sediments again—sometimes exposing dinosaur fossils such as the hadrosaur tail that paleontologists discovered in Grand Staircase-Escalante National Monument.

National Monuments: America's Treasures

A monument is a special tribute to someone or something. Many people think of the Washington Monument or the Statue of Liberty when they hear the term national monument. But, in fact, there are more than 100 national monuments all around the country. National monuments are places that have special historic, scientific, or cultural value to the American people.

The President or Congress can designate a national monument to protect resources of scientific and historic interest. A monument can be a small property containing a statue or building, or it can be a vast expanse of land.

Grand Staircase-Escalante National Monument contains almost 770,000 hectares (1.9 million acres). It was created in 1996 as the first national monument to be placed under the care of the Bureau of Land Management. Remote and rugged, it is the last place within the continental United States to have been mapped.

As an unspoiled natural area, Grand Staircase-Escalante offers many opportunities for scientific study. Geologists, paleontologists, archaeologists, historians, and biologists are all exploring this outdoor laboratory. Rock arches, hanging gardens, petrified forests, Native American artifacts, and, of course, fossils are just a few of the natural and cultural treasures the monument contains. By law, the scientific resources at Grand Staircase-Escalante must be protected.

Since 1996, 14 additional national monuments have been designated on lands managed by the BLM. They are part of BLM's National Landscape Conservation System, which also includes national conservation areas and wild and scenic rivers. Established in 2000, the National Landscape Conservation System is designed to protect some of the nation's most remarkable and rugged landscapes.

Partners in Discovery

The Bureau of Land Management: A Small Agency with a Big Mission

The Bureau of Land Management (BLM) is a Federal agency that takes care of federally owned public lands. A small agency with a big mission, the BLM is part of the Department of the Interior. Two other agencies in this Department that manage federally owned lands are the National Park Service and the U.S. Fish and Wildlife Service. The BLM manages 107 million hectares (264 million acres) of public lands—almost *one-eighth* of the United States. In fact, the BLM manages more land than any other single agency in the country.

Like all lands managed by Federal, State, and local agencies, public lands belong to you and all Americans. And like national parks, national wildlife refuges, and national forests, the BLM public lands are great places to hike, bike, camp, canoe, watch wildlife, and learn about the past. Their vast open spaces provide a welcome refuge from the pressures of crowded cities.

BLM lands also help the country prosper by providing coal, oil, gas, timber, forage for livestock, and other natural resources. Most BLM lands are in the Western States, including Alaska. But the BLM works in the Eastern States too, surveying land, finding homes for wild horses and burros, and helping communities get raw materials such as coal, lead, phosphate, oil, and gas.

Twenty-five years ago, Congress passed a law (the Federal Land Policy and Management Act of 1976) that said public lands should be available for many uses to best meet the present and future needs of the American people. The BLM's mission still reflects this philosophy today.

The Museum of Northern Arizona: Celebrating Our Natural and Cultural Heritage

Founded in 1928 as a community effort by a group of Flagstaff citizens, the Museum of Northern Arizona is a private, nonprofit institution that was originally established as a repository for Native American artifacts and natural history specimens from the Colorado Plateau. The original founders, zoologist Dr. Harold S. Colton and artist Mary-Russell Ferrell Colton, who were from Philadelphia, Pennsylvania, were dedicated to preserving the history and cultures of northern Arizona. Over its 72-year history in Flagstaff, the museum has evolved into a regional center of learning with collections, exhibits, educational programs, publications, and research projects that serve more than 100,000 people each year. As the only accredited museum within 240 km (150 miles) of Flagstaff, and the only natural history museum within 400 km (250 miles), the Museum of Northern Arizona plays a vital role as interpreter of the Colorado Plateau. The museum's paleontology collections include many important fossils from southern Utah, especially from the area now called Grand Staircase-Escalante National Monument. Among those fossils are some of the earliest mammals known, from the time when dinosaurs dominated the landscape and mammals were no larger than modern shrews and moles. For more information about the Museum of Northern Arizona, check the museum Web site: *http://www.musnaz.org*.

Activity

Assess and Investigate

Objective

To research information about public lands managed by the Bureau of Land Management, including the National Landscape Conservation System.

After the information on pages 26-27 has been presented, check to see how much your students know about national monuments and the Bureau of Land Management (BLM). Have them answer some of the questions below. Following this quick assessment, encourage students to find out even more about the BLM, its national monuments, and its National Landscape Conservation System. Web sites that can serve as starting points for their research are included below.

- Who owns the public lands?
- Where are most of the BLM public lands located?
- Name three things that BLM's public lands provide to the American people.

Web sources:
BLM national Web site: *www.blm.gov*
BLM education programs: *www.blm.gov/education*

Have students use the map on page 22 to find the BLM public lands that are located closest to you. They should use the scale to determine how many kilometers (or miles) away these public lands are from their homes. A map is also available at this Web site: *http://www.blm.gov/nhp/facts/index.htm*

- A national monument pays tribute to what?
- What is the purpose of the BLM's National Landscape Conservation System?

Web sources:
BLM National Landscape Conservation System: *http://www.blm.gov/nlcs/*
BLM national monuments: *www.blm.gov/nlcs/monuments/index.html*

Have students name a national monument in your State. They can find information on State tourist office Web sites or on *www.recreation.gov*, a Web site featuring recreational opportunities on all federally owned lands.

Have your students ever visited BLM-managed lands? If so, have them write stories or draw pictures about their experiences.

Fossils: Impressions in Time

A fossil is defined as any remains of prehistoric life (older than about 5,000 years). Fossils are divided into two main categories: body fossils and trace fossils. Body fossils consist of some actual part of an organism, such as a leaf, tooth, skin, bone, feather, or petrified wood. Also included in this category would be molds and impressions of these same parts. The other major kind of fossil is a trace fossil—evidence of an organism's activity. Trace fossils include things such as tracks, trails, burrows, scratch or bite marks, nests, and skin impressions.

In many ways, trace fossils can give us more information about how the animal lived than bones or teeth can. For instance, dinosaur footprints have been used to help reveal dinosaur behavior, such as how fast they could run, whether they lived in herds, and what they might have eaten. In some cases, thousands of footprints have been found in areas where no bones have been found!

How Are Fossils Formed?

Organisms become fossils in many ways—a fish sinks to the bottom of a lake and is buried in soft mud, animals grazing on the plains are buried by the sudden eruption of volcanic ash, shell debris accumulates slowly on the ocean floor. In some cases, all the original parts of a life form are preserved. Stunning examples of this have been found in the tundra areas of Alaska and Siberia, where frozen mammoths and other animals have been found with their last meals in their stomachs. However, this is rare.

Fossilization is a rather chancy business. Fossil formation is affected by the rate of burial of the remains (dead organisms). Organisms have a better chance of being preserved if they have hard parts, such as bones, shells, teeth, or wood. Such hard parts are less likely to be disturbed or eaten by other organisms. The permineralization of remains (sometimes called petrification) and the mold-and-cast process are two ways in which these hard parts of organisms eventually produce fossils.

Permineralization occurs when ground water containing dissolved minerals seeps into the tiny natural openings of buried bones or other porous parts of dead organisms. As the water slowly passes through the remains, the minerals crystallize and settle out, filling the pores. Permineralized remains are hard and rocklike because the original hard parts of the bone are preserved and pore spaces in the bones are also filled in with minerals that have hardened.

In the mold-and-cast process, the sediments around an object are compacted and cemented until they become rock. A mold results when the original object is dissolved in ground water. All that remains is an imprint of the outside or inside surface of the object. Later, minerals may fill the mold, harden into rock, and produce a cast of the original object.

In the case of many traces, like dinosaur tracks, there are also molds and casts. Molds are the imprints of the bottom of feet, and casts are the replicas of the actual feet made by mud that filled in the molds after they were made.

Activity

Set in Stone

Objective

To demonstrate how a fossil can form through the process of permineralization.

The hadrosaur fossil in the broadcast formed over millions of years through the process of permineralization. The original bones are still there, but pore spaces in the bone have been filled in with minerals that have hardened over time. Your students can replicate this process with a few simple materials. If possible, have each student make his or her own permineralized fossil.

Materials

- sponge (For authenticity's sake, the sponge could be cut in the shape of a bone.)
- nontoxic white glue
- water
- paper plate or aluminum foil
- paper cup or other container

Procedure

1. Dilute the glue slightly by mixing it with water—about nine parts glue to one part water.
2. Place the sponge on the plate or foil.
3. Gradually pour the glue-water mixture into the sponge until it is completely saturated. In other words, stop when the sponge can no longer absorb any more glue.
4. Set the sponge aside and let it dry for at least 24 hours.

Have students examine their "fossils." What can they see? How does the sponge feel? Like the hadrosaur bones in the broadcast, the empty spaces in the sponge filled in with "minerals" in the form of the glue-water mixture. The glue hardened, and while the original sponge is still there, it has become hard.

Activity

Make Your Own Fossil

Objective

To demonstrate how a fossil can form through the mold-and-cast process.

In nature, the fossilization process takes years. Using plaster of Paris and a natural object, your students can find out how mold fossils are formed in about 24 hours. Ideally, each student should be able to make his or her own "fossil."

Materials

- plaster of Paris
- large paper cup or 0.5-L milk carton with the top cut off
- petroleum jelly
- natural object such as a leaf, shell, or small bone (needs to be small enough to fit in container)
- clay

Procedure

1. Have students fill their container about halfway with plaster of Paris. They should then add water and stir until the mixture is smooth and thick like cottage cheese.
2. Next, students should spread petroleum jelly over the leaf, bone, shell, or other natural object.
3. Then, have them press the object into the plaster of Paris.
4. They should let the plaster dry for at least 24 hours.
5. Finally, they should remove the object. The imprint made in the hardened plaster is similar to mold fossils of organisms and their traces (such as tracks).

Extension

Have your students experiment with other materials to see which ones would preserve fossils the best. For instance, if they could press shells into mud, wet sand, wet gravel, and clay, which material do they think would make the best imprint? Have students make predictions and test them.

Extension

Paleontologists make casts from molds using rubber or plastic compounds. Students can also make cast fossils. In nature, these are created when a mold fossil becomes filled with minerals, which then harden. In order to create a cast fossil, students will need the molds they made in the activity above. They should spread petroleum jelly over the surface of the imprint. Then they will take modeling clay and press it into the mold. Once the clay has hardened overnight, students will have created a cast fossil.

Fossilization: The Great Coverup

The vast majority of animals and plants that have lived on Earth did not leave fossil evidence of their existence. Many pieces of evidence are missing completely, such as the remains of soft-bodied animals like worms. Even so, many invertebrates (animals without a spinal column) like snails and clams have left millions of fossils. With the exception of some fish and sharks, fossils of most animals with backbones, such as dinosaurs, are much more rare.

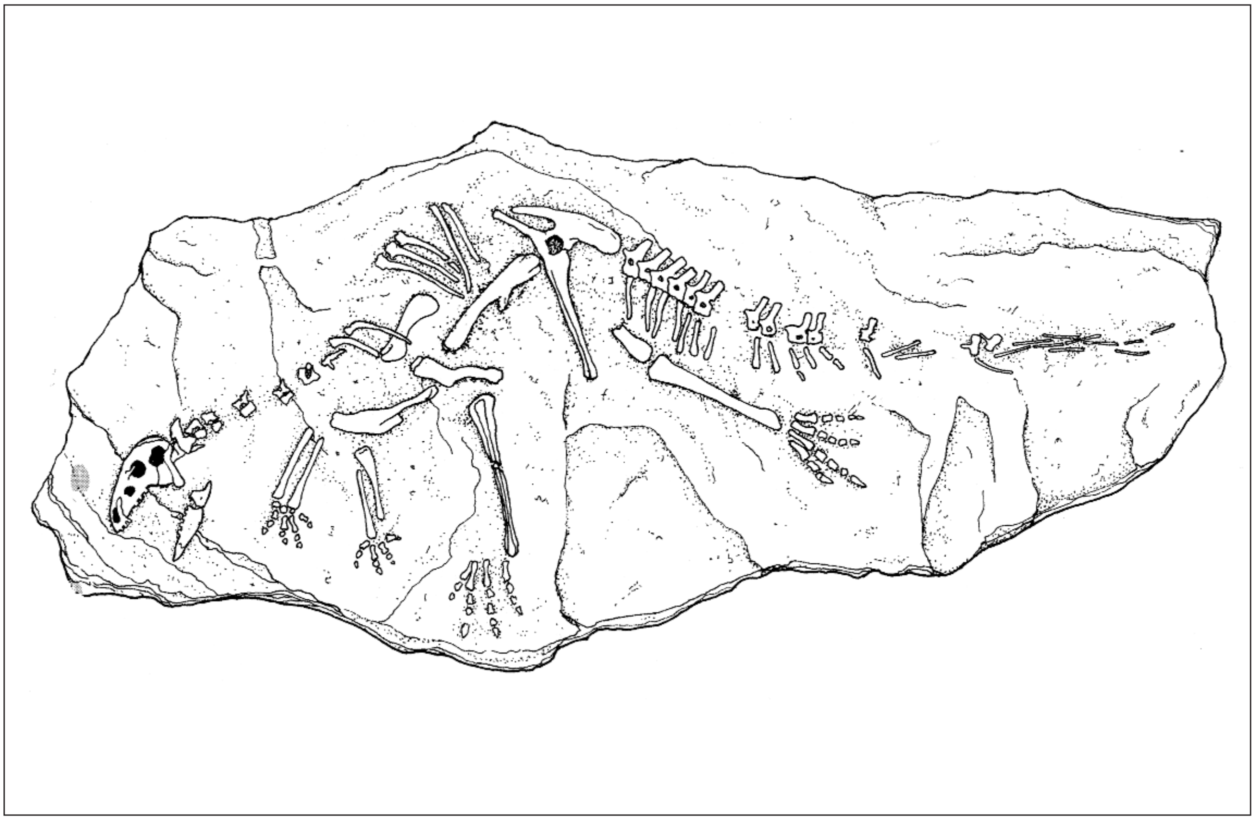
The chances of a given individual being preserved in the fossil record are very small. Some organisms, however, have better chances than others because of the composition of their skeletons or because of the place where they lived and died. In addition, much is lost in the fossilization process. Much of what we consider important about human biology is in the soft tissues, such as skin, hair, and internal organs. These characteristics would usually be unknown in the fossil state because, most of the time, only bones and teeth are preserved.

Picking Up the Pieces

To complicate the picture even more, plants, invertebrates, and vertebrates are made up of different parts that can separate after death. The different parts can be transported by currents to different locations and 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.

A complete dinosaur skeleton consists of around 300 separate bones, each having distinctive features. From these bones, paleontologists can identify the different types of dinosaurs and develop a picture of what they looked like (including their size, shape, and posture), how they existed, what they did, where they lived, and how they traveled.

It is very unusual for paleontologists to find a complete dinosaur skeleton—or even a complete section of a skeleton, such as the hadrosaur tail in Grand Staircase-Escalante. At most sites, paleontologists are usually working with scattered bones. When scientists find the bones of different dinosaurs in the same area, they must first identify the bones, closely study them or even mold them to show how they fit together, and then separate them before the bones can be assembled. Any fully mounted museum skeleton is a tribute to the enormous effort of those involved in obtaining and assembling it.



Paleontologists rarely find a complete skeleton of a dinosaur such as the one illustrated above. Instead, pieces may be scattered over a large area or missing completely.

Activity

The Fossilization Game

Objective

To examine some of the ways in which natural forces affect fossil formation.

Materials

• fossilization cards (see pages 36 and 37)

Procedure

1. Have the class choose an environment. It should be one in which deposits of sediment occur fairly quickly, such as a lake, pond, stream, river in a forest, or sea floor. Students should take some time to describe this setting in as much detail as possible.

2. Students should choose roles such as animals or plants that might live in the chosen setting. For example, in the aquatic settings, possible roles include not only snails, clams, fish, salamanders, turtles, alligators, and other aquatic animals, but also horses, deer, monkeys, rabbits, and birds that came there to drink.

3. Begin play. When play begins, players should be allowed to act out their roles, with each one given a turn to make vocalizations or gestures. For example, a student playing a fish could wiggle his or her body with a fishlike motion and make gulping motions with the mouth.

4. "Freeze" and decide the fate of the characters. At a time determined by a predesignated timekeeper, action freezes and the time for possible fossilization begins. Each student draws a card that tells the fate of his or her plant or animal. For example, the cards might say, "You are eaten by scavengers," "You rot away before you can be preserved," "You are swallowed by a crocodile," or "You are buried by a mudslide and preserved as a fossil." (You can make several copies of the pages of cards included with this activity, or you can make your own. If you do make your own, the proportion of "fossilization" cards to "destruction" cards should be small, mimicking the small chance of becoming fossilized in the real world.)

5. When the entire class has drawn cards, discussion can begin. Have each player discuss his or her role as an organism and what happened to this organism after it died. Make a list of these organisms on the blackboard. Which animals became fossils? Which were destroyed? Remember, the only animals and plants future paleontologists will know anything about are the ones that become fossils. Students will become aware of the important question of bias in the fossil record when they compare the list of fossils with the complete list of living animals. Is the list of fossils a good representation of the living community? Why not?

Fossilization cards:

Dry Up	Dry Up
Rot Away	Rot Away
Rot Away	Swallowed by Alligator
Swallowed by Crocodile	Swallowed by Crocodile
Swallowed by Big Fish	

Swallowed by Big Fish

Swallowed by Big Fish

Eaten by Scavengers

Eaten by Scavengers

Buried in Soft Mud—You Become a Fossil

Buried in Soft Mud—You Become a Fossil

Washed Away by Waves

Washed Away by Waves

Washed Away by Current

Washed Away by Current

Activity

Paleopuzzles

Adapted with permission from Investigating Science with Dinosaurs, *by Craig A. Munsart. © 1993 Libraries Unlimited. (800) 237-6124 or www.lu.com.*

Objective

To demonstrate some of the difficulties involved in classifying and assembling dinosaur fossils .

In this activity, your students can get an idea of the effort required to unravel the mysteries of a fossil locality. Although the process is simplified, some of the frustrations and uncertainties of an actual site will become clear.

Materials

- photocopies of the four bone diagrams on pages 40–43 (preferably on card stock)
- scissors
- envelopes
- tape or glue
- large sheets of paper

Procedure

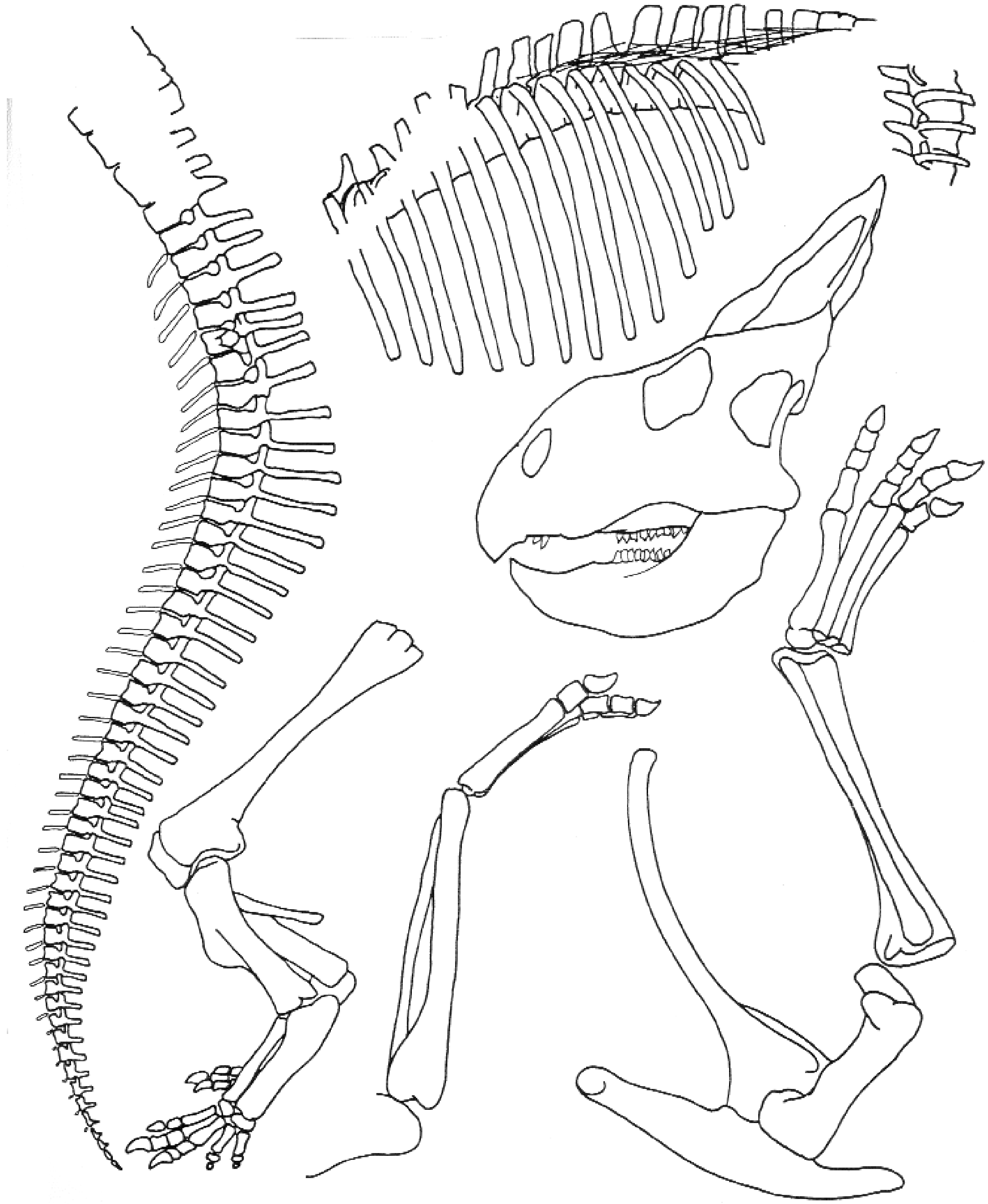
1. Divide your students into pairs and distribute copies of the bone diagrams to the class. Each pair of students should get three diagrams. Different pairs may have the same skeletons. Also give each pair of students an envelope.
2. Have the students cut around parts of the skeleton in each of the three diagrams, leaving a small border around the cutouts to reduce the chances of damaging the bones. Each pair of students should then put all of their cutouts in their envelope.
3. Collect the cut skeleton sections from each pair of students. Dispose of all scrap paper and collect the scissors. (To make the activity more challenging, remove or add bones from selected envelopes, without the students' knowledge. A significant complicating factor is removal of the skull, because the students then will not know how many animals skeletons are represented.)
4. Give each pair of students an envelope containing the parts of three skeletons along with the following instructions:

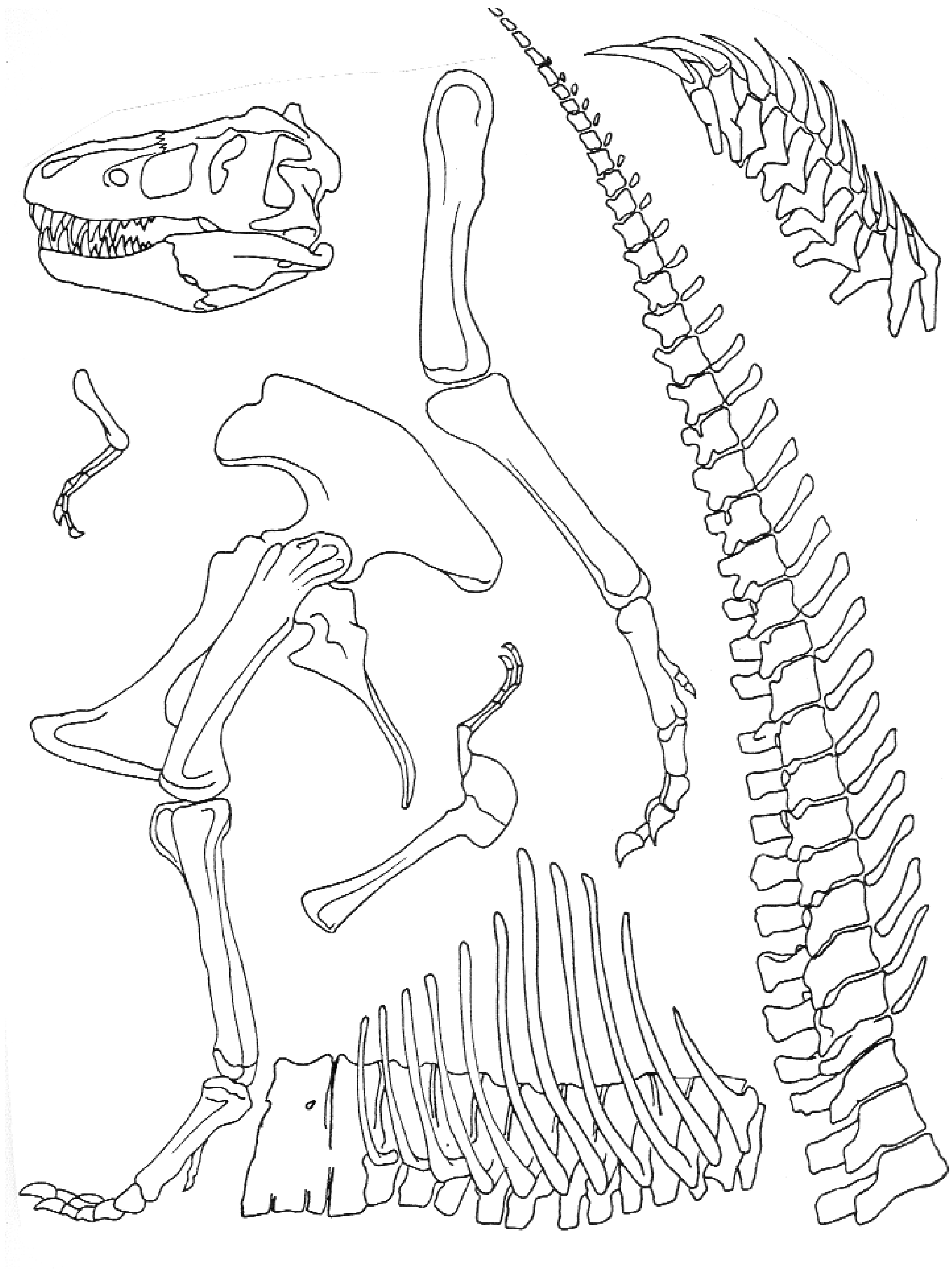
You and your partner are on a museum expedition to a foreign country that has discovered a new fossil locality. Not much is known about the bones. No one knows what the animals looked like, how big they were, how many animals are in the fossil locality, or whether they are all the same or all different. The skeletons may be complete or parts may be missing. There may be extra bones. Your museum has asked you to solve the mysteries of the fossil locality. How many animals are there? What did they look like? Based upon the evidence you have, what can you discover about the animals? Were they carnivores or herbivores? Did they walk on two legs or four? At the conclusion of the dig, you will prepare a detailed written report and present your findings to the board of directors of the museum (the rest of the class).

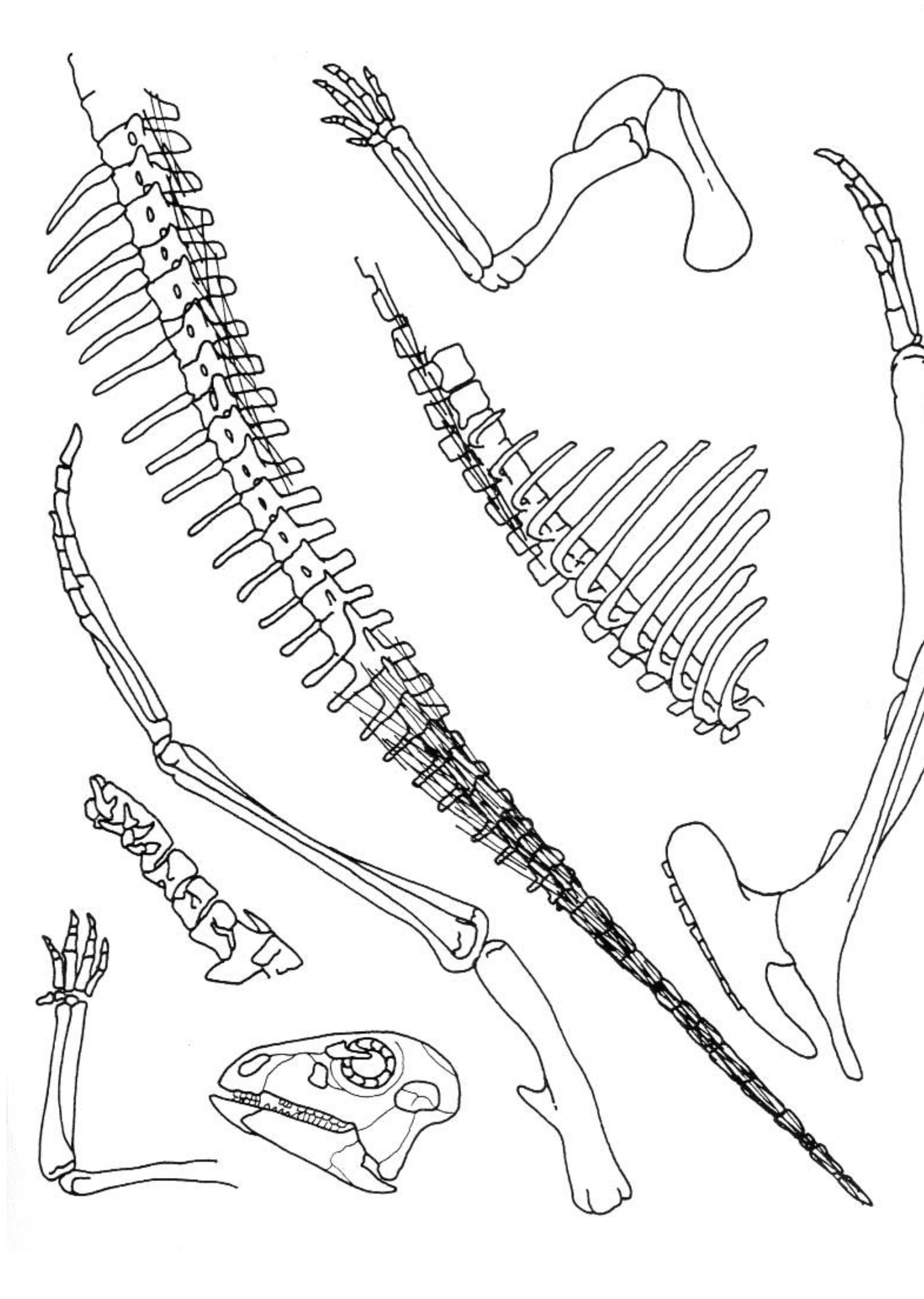
5. Advise students that there is no correct way to assemble the skeletons. Because they are the first people to find these bones, any reasonable assembly is acceptable as long as they can defend their choices.
6. Have each pair of students dump the contents of their envelope into a small pile. This is their "fossil locality." Distribute tape or glue and large sheets of paper to each pair. Remind them to try different arrangements of the skeleton pieces until they are satisfied the bones all fit. Only then should they assemble them by taping or gluing them to the paper.
7. Afterward, student pairs should present their assembled dinosaur skeletons and explain the methods they used. The class, serving as the museum board of directors, should be encouraged to ask questions of the presenters.

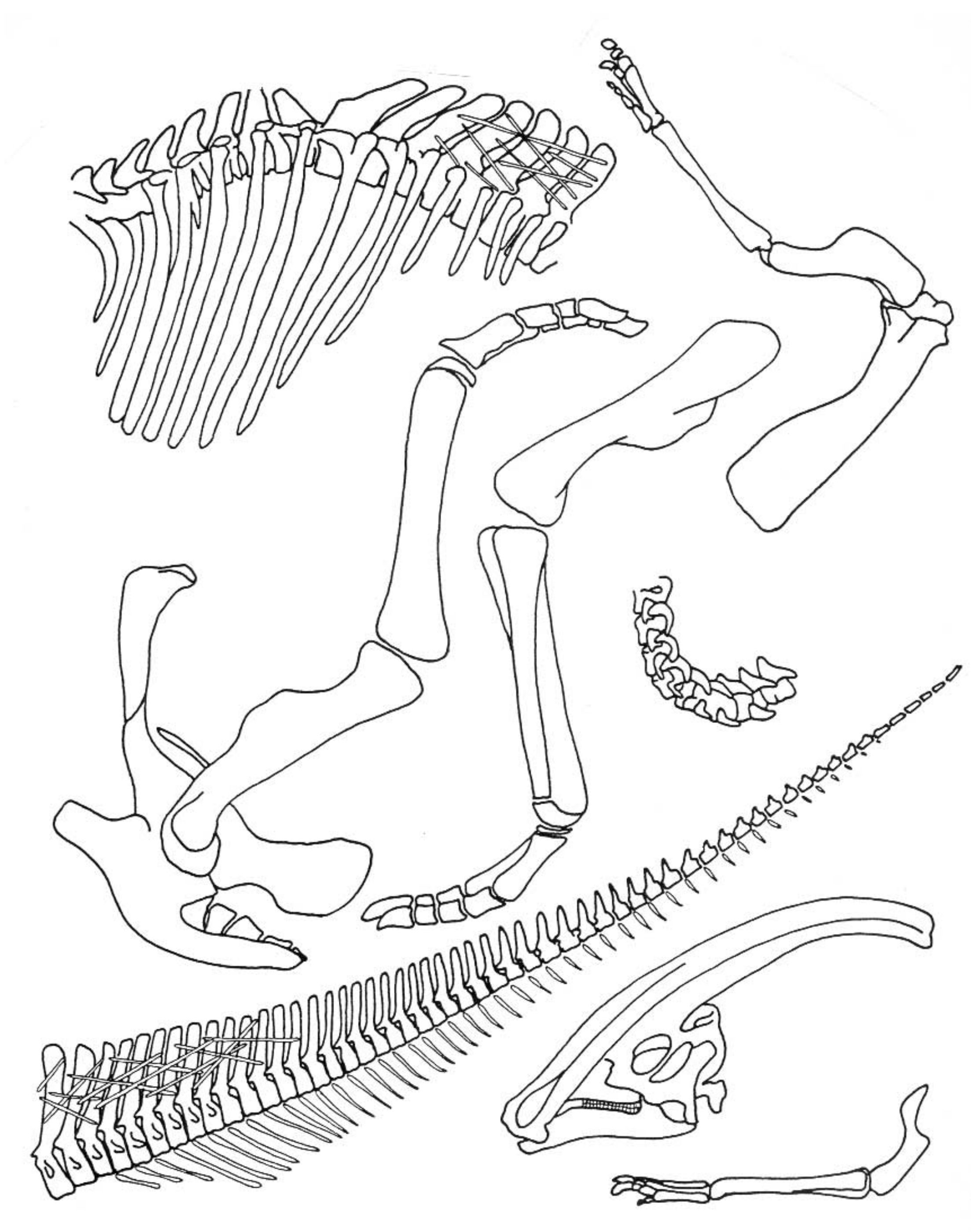
Extension

In a smaller class, have students sit in a circle on the floor. Dump all bones from all the envelopes into the middle of the circle to create a large bone site. Divide the class into small discovery groups. Taking turns, each group can select three or four bones until all bones have been distributed. The groups will then have to assemble their dinosaurs based only upon the bones they have. Many skeletons will be incomplete, but this provides a more realistic simulation of a dig.









Activity

The Road to Immortality

Objective

To illustrate the quality of information that comes from the fossil record.

Materials

• pictures of living animals and their skeletons

• pictures of dinosaur skeletons

Procedure

1. Have students list facts about a living animal, such as a horse. The list of facts on the horse might include—but not be limited to—large size, fast runner, eats grass, has grinding teeth, has long hair for a mane and tail, whinnies, is intelligent, is sociable with other horses, makes a good pet.

2. Ask your students, "What would we know if this animal were extinct?" Show students an image of a horse skeleton and point out an important generalization of fossilization—that most of the time, only the hard parts (bones and teeth) are preserved as fossils. Go through the list of characteristics about the horse and ask the class what we would know about horses if they were extinct and all we had were fossilized bones and teeth. We would know that they were large animals and could probably make some good guesses about their weight. We would know that they had grinding teeth and, therefore, we could probably guess that they ate some sort of tough vegetation like grass. The hooves would not be preserved, but the shape of the foot bones would be a good indicator that they had hooves. The skeleton would also be useful to tell us they were fast runners. Few, if any, details of the hair or skin would be known. Everything about social behavior and socialization would have to be guesses.

3. Pass out a picture of any dinosaur skeleton (see Resources for possible sources). Have the class draw muscles and skin on the skeleton. Explain to your students that skin color and texture are largely the choice of the artists, since fossil bones provide no clues, although some skin impressions have been found.

Activity

Missing Pieces

Objective

To make an inference about the appearance of a dinosaur based on observation and research.

The paleontologists at Grand Staircase-Escalante National Monument and the Museum of Northern Arizona believe that the fossilized tail they have been excavating belonged to a hadrosaur, perhaps of the genus *Parasaurolophus*. On what do they base this inference?

Distribute copies of the drawing of the dinosaur tail on the following page. Have your students conduct research and come up with their own inferences about what the complete dinosaur looked like. They could consult some of the resources listed at the end of this guide or pursue their own research in the library or on the Internet. Following their investigations, have students draw the rest of the dinosaur as they think it may have appeared. If time allows, they should color their drawings as well.

After everyone in the class has finished drawing, artwork should be shared. On what information did they base their drawings? Discuss ways in which more information about the dinosaur could be obtained and more accurate drawings made. For example, more of the fossil could be uncovered or other similar fossils could be discovered in the area or elsewhere.

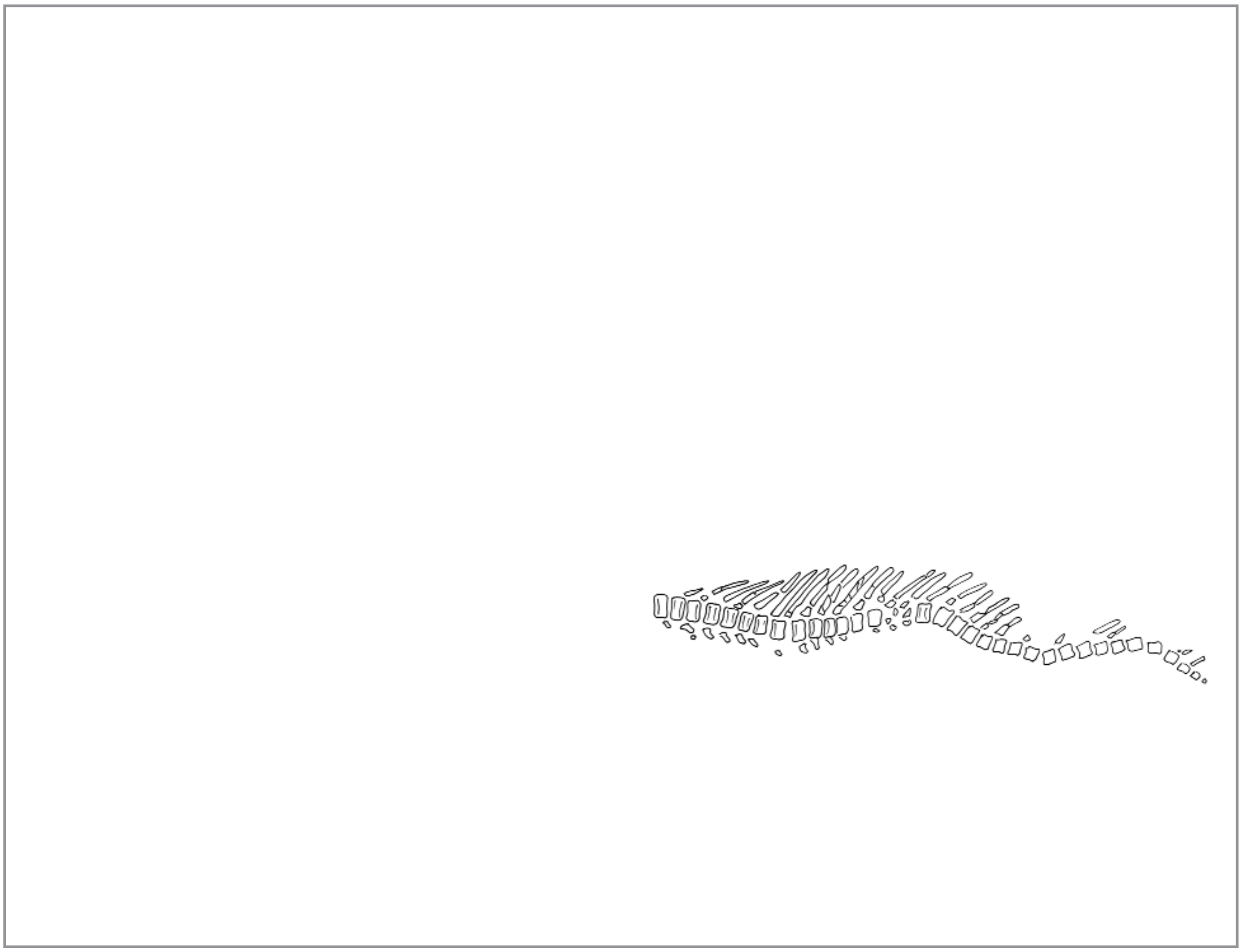


Illustration courtesy of Merle Graffam and the Museum of Northern Arizona.

Fossils: Clues to the Past

Fossils tell us a story of change. Climate, life, even the positions of the continents themselves have undergone constant change throughout the history of our planet. The Earth is more than 4 billion years old, but humans have only been around for the last 2 million years—and modern humans for only 100,000 years or so. That is much too short a time to have witnessed all our planet's changes. Fossils provide us with the evidence of many of those changes. Through the science of paleontology, we can begin to understand Earth's long history.

Here are a few things fossils can tell us:

1. Because fossils represent the remains of once-living organisms, they can tell us about the many different kinds of plants and animals that lived on Earth over millions of years. Unlike modern biologists, who can usually identify every part of a modern ecosystem, paleontologists have to contend with "missing pieces," such as the remains of soft-bodied animals. In spite of this, studying fossils adds to our understanding of the diversity of life and of how life has changed through the ages.

2. Scientists can determine the age of rock(s) when they determine the age of the embedded fossils. Dating rocks allows paleontologists to compare one region to another and put together the "big picture" of who, what, where, why, and when.

3. Looking at how fossils are distributed around the world can tell us where continents and oceans were located at different times in the geologic past. Continents are continually moving (about as fast as your fingernails grow), and as one land mass collides with another, animals migrate back and forth. The movement of animals from one place to another through time provides evidence that land areas were once connected. For example, the presence of *Tyrannosaurus rex*-type dinosaurs in both Asia and America shows that these two areas were joined together by land near the end of the age of dinosaurs.

4. Studying fossils gives us a sense of place. Their story is really our story since fossils record the history of how Earth came to be the way it is today.

Activity

Fossil Clues

Objective

To demonstrate the way in which paleontologists use fossil clues to make inferences about ancient life.

In order to develop their ideas about what life was like in the past, paleontologists rely on their observations and their research, as well as their knowledge of life in the present. Pretend that your class is a team of paleontologists exploring an area for the first time. Over the course of several weeks, they have discovered a series of interesting fossils. Present your students with the following fossil clues. For each fossil discovery listed, they should brainstorm inferences they might make about the organism or the past environment of the place being explored. Discuss how they came up with their ideas. How would they find more information that would help them determine whether their ideas are correct? To help you, we've done one for you.

- A fish

  What we know: Modern fish live in water.

  Inference: There must have been water at this site.

  How we could determine if this inference is true: We could try to find more fossils of fish or other animals that lived in water.

Now have your students try the same exercise with these "fossil finds":

- A magnolia leaf
- A large animal jaw with sharp, blade-like teeth
- Bones of a frog
- Vertebrae (backbones) of a small animal with teeth marks on them
- Various-sized footprints of what appear to be the same type of dinosaur

Activity

Make a Timeline

Objective

To illustrate significant events in Earth history on a scale model (indoors or outdoors).

Materials

- list of significant events in Earth's history and measurements (below)
- metric measuring tape
- wooden stakes or flags (outdoors) or adding machine paper (indoors)

Procedure

1. Decide whether this will be an indoor or outdoor activity. For the indoor timeline, mark the events on the adding machine paper. For the outdoor version, use flags or wooden stakes.
2. Create your timeline using the events and measurements in the table below.

Earth Event	Years Ago*	Indoor	Outdoor
Earth begins	4.5 billion	11.6 meters	45.7 meters
Life begins	3.5 billion	8.9 meters	35 meters
First fossils form	3.4 billion	8.5 meters	34 meters
First primitive fish	450 million	1.1 meters	4.5 meters
Earliest land plants	410 million	1 meter	4.1 meters
Early amphibians/swamp forests	300 million	76 cm	3 meters
First reptiles	290 million	74 cm	2.9 meters
Beginning of age of dinosaurs	225 million	57 cm	225 cm
Early birds (*Archaeopteryx*)	160 million	41 cm	160 cm
Flowering plants develop	130 million	33 cm	130 cm
Dinosaurs extinct/age of mammals begins	65 million	17 cm	65 cm
Mammals/birds abundant	50 million	13 cm	50 cm
First humans	2 million	5 mm	2 cm
Ice age begins	1.5 million	4 mm	1.5 cm
United States created	225	.0025 mm	.0002 cm

*Years ago are approximate and based on fossil evidence.
Scale: Indoor 2.5 mm = 1 million years; outdoor 1 cm = 1 million years.

For students to consider:

- Have the class look at the long portion of the timeline that represents the age of dinosaurs. While it may look short compared to the length of the entire timeline, dinosaurs were actually very successful as a life form. They roamed the Earth for about 160 million years.
- Then have your class compare that to the length of the age of mammals or the even shorter period of time during which humans have lived on Earth.

Activity

The Geologic Time Scale

Objective

To research characteristics of the four major eras of geologic time and to determine possible contemporaries of a recent fossil discovery—the hadrosaur at Grand Staircase-Escalante National Monument.

Fossils provide a record of how the Earth and its organisms have changed. Scientists have used the appearance and disappearance of organisms in the fossil record to divide Earth's history into units of time. These units are organized in a chart called the geologic time scale. There are four major eras of the geologic time scale: Precambrian, Paleozoic, Mesozoic, and Cenozoic. Divide the class into four groups and assign each group to research one of these eras. Perhaps each group could create a mural highlighting the major life forms and events in its assigned era.

Dinosaurs lived for a relatively short time period from 225 to 65 million years ago. This was during the Mesozoic era, which is divided into three periods:

Triassic (248-193 million years ago)
Jurassic (193-136 million years ago)
Cretaceous (136-65 million years ago)

The fossil record shows that dinosaurs, like virtually every other kind of organism, changed over time. Have students consult some of the dinosaur books and Web sites listed in the Resources section to determine which dinosaurs lived during the same period as the hadrosaur at Grand Staircase-Escalante National Monument.

Fossil Collection: Do's and Don'ts

Fossils can be found in just about every region of the country. Some places, however, are more likely to contain fossils than others.

Sedimentary rocks produced in oceans, lakes, rivers, caves, and flood plains of rivers are often good places to look for fossils. The shells and other hard parts of animals that live in these places accumulate over a period of months or years and then are buried by sediments.

Fossils found on federally owned public lands, including those managed by the Bureau of Land Management (BLM) are jointly owned by all Americans. They are a rare part of our natural heritage and need to be protected.

If you are interested in collecting fossils, be sure to check with the landowner or land manager to determine whether or not fossil collecting is permitted, and if so, what types of collection are allowed. Different places have different rules. In some areas, such as BLM's Grand Staircase-Escalante National Monument, only trained professionals may collect fossils. In all cases, it is illegal to collect vertebrate fossils (fossils of animals with backbones) from public lands.

When in doubt, leave it alone. If you have any question about a fossil you have found, leave it where you found it until you have your questions answered by an expert.

Remove a fossil only if there is a purpose in taking it, such as to study it. Do not take rare fossils. Once a fossil is removed from its environment, it cannot tell its story to others who visit.

Volunteer! If you are interested in serious fossil collection, many museums and colleges offer opportunities for volunteers to study and work alongside trained professional paleontologists.

You should always follow standards of professional ethics, including discussing your findings with experts in a position to recognize exceptional or valuable specimens. Fossils of all kinds are the only direct evidence we have of past life. As such, they are irreplaceable natural resources for science.

For more information about fossils on BLM lands in your area, contact the BLM office near you. You can find the location of the nearest BLM office on the BLM national Web site (*www.blm.gov*) or in the blue pages of your local telephone directory.

Activity

What Would You Do?

Objective

To examine and discuss responses to hypothetical situations involving the ethics of fossil collecting.

After your students read "Fossil Collection Do's and Don'ts," they should have a greater appreciation for the value of fossils and the importance of protecting our country's fossil resources. To enhance their understanding, present students with several situations and have them consider possible responses. Students should be encouraged to discuss the factors that influenced their reactions.

Procedure

Divide your students into small groups for discussion and give each group a copy of the situation they are to consider. Appoint one person to take down the responses. Ask them to consider each situation presented and come up with their reactions to the situations. After they have talked about their responses, get together as a class and discuss the different responses.

Situation 1: You are an amateur geologist, a "rock hound" out for the day, looking for interesting rocks to identify. You come across a fossilized bone sticking out of a hillside. You are familiar with excavation techniques because you have read all about it in books. What would you do?

Situation 2: Your hobby is collecting fossils. Every time your family goes on vacation, you go to privately owned places to collect fossils. You also like to visit BLM areas with fossils to learn about the fossils that are found there. A family has moved in next door that shares your interest in fossils and has a large collection. You are looking at their collection one day and see what looks like part of a dinosaur jaw with a few sharp teeth. You ask where they found it and they say it came from BLM land in Utah. What would you say or do?

Situation 3: A few years ago, you and your family collected fossils of trilobites and brachiopods from a nearby quarry. Your parents have kept them in boxes on the shelf since then. Now your family is going to have a yard sale. To make room for books and CDs, your parents have decided to sell the fossils. What would you say to them?

Followup Activities

What Exactly Is a Dinosaur?

Objective

To identify and analyze relationships among prehistoric animals and develop classification skills.

When people think of dinosaurs, what is the first thing that comes to mind? Probably some fierce, large predator like those that appeared in the *Jurassic Park* movies. The word "dinosaur," in fact, comes from Greek words meaning "terrifying lizard." But were all dinosaurs terrifying? And were they really lizards? An exercise in classification should help students explore these not-so-simple questions.

In this activity, your students fill in a semantic feature analysis chart, a method of graphically analyzing relationships among many different species. This allows them to develop vocabulary, categorization, and classification skills and to identify relationships.

Prepare a grid with a variety of prehistoric animal types listed on the left side of the grid and features or characteristics written across the top. (See an example of such a chart below.)

If a characteristic is present in a certain type of animal, students should mark a plus (+) in the space; if it is not present, students should mark a minus (-). Grids can be prepared individually or in small groups, or a large wall-sized grid can be used by the entire class.

	Older than 230 million years	Younger than 66 million years	Primarily flies	Primarily swims	Legs to the side	
ANIMAL						
Dimetrodon	+	–	–	–	+	
Pteranodon	–	–	+	–	–	
Mammoth	–	+	–	–	–	
Plesiosaur	–	–	–	+	–	
Triceratops	–	–	–	–	–	

Activity

Inquiry on the Colorado Plateau

Objective

To examine the way in which paleontologists are using the inquiry method in connection with the discovery of a hadrosaur fossil at Grand Staircase-Escalante National Monument.

Students participating in the satellite broadcast should develop a deeper understanding of the way in which paleontologists use the inquiry method in their work. As the name implies, the inquiry method involves asking questions and then developing a plan of action to help answer those questions. This plan could include making predictions and developing hypotheses, coming up with methods to test the hypotheses, and then performing those tests.

Have your students create a class list of questions that the paleontologists in the broadcast are attempting to answer. Among the questions students might list are:

- What kind of dinosaur is being excavated?
- How did it come to rest in this location?
- How much of the dinosaur is here and what happened to the rest of it?
- When did this dinosaur live?
- What other animals lived with it?
- In what kind of environment did the dinosaur live?
- What does this fossil tell us about the creature's anatomy and behavior?

Once a list has been developed, discuss with your class whether the scientists have yet been able to answer any of the questions and, if so, how. Were they able to come up with answers immediately in the field or later in the laboratory at the Museum of Northern Arizona? As with many aspects of scientific inquiry, students will learn that few definitive answers suggest themselves immediately. It is more likely that additional questions will come up requiring still more hypotheses and tests. Encourage your students to cite specific steps in the inquiry process that they observed in the broadcast.

Then ask the class to develop a new list of questions that remain to be answered. (This list could include some or all of the questions from their first list.) Divide the class into teams of two to three students. Have each group choose one of these questions and brainstorm a specific plan for attempting to answer it.

Activity

Inquiring Minds Want to Know

Objective

To apply the inquiry method in a scientific study.

The inquiry method is not exclusive to paleontologists attempting to unravel the mysteries of dinosaurs. It is, in fact, a common approach to many scientific studies and can be practiced in the classroom as well as in the field or in a laboratory. The first step, of course, is to provide opportunities for students to observe their surroundings and ask questions. And opportunities abound!

Consider performing some simple classroom demonstrations based on a current unit of study. With this approach, your students will have concrete experiences with the topic they will be investigating. A visit to a nearby natural area also provides opportunities for observation. (Ideally, if time allows, a series of increasingly complex inquiry exercises could take place over the course of several weeks.) Encourage your students to use all their senses in making their observations and to use a journal to record what they observe. Their descriptions can include both words and pictures.

Next, encourage the class to come up with questions based on their observations. No limits should be placed on the number of questions. After all, the goal is to inspire curiosity. As a result of their observations, your students will know certain facts, but they will also realize what they don't know. These unknowns form the basis for their questions. From their list of questions, students should pick one that they would like to investigate further.

The next step is to come up with a plan of action that includes making predictions about what the results might be and deciding the best way to test them. At this point, some guidance may be necessary. Questions should be clear in order for investigations to work. Some students may need to be reminded about the importance of changing only one variable in an experiment and about the value of keeping detailed and accurate records of their findings. Library (or Internet) research may prove valuable in their investigations as well.

Preparing reports on findings is the final step in the inquiry process. Reports can be written or oral and should include a statement of the question being examined, a description of the investigation performed, and interpretation of the results. Most students will probably discover that, in the process, they have come up with many more questions that they would like to investigate. So while the report may be the final stage, it can also be the beginning.

Glossary

Articulated: Joined together.

Awl: A pointed tool that is used for piercing holes.

Cretaceous: The most recent of the three periods of the Mesozoic era—the "age of dinosaurs." The Cretaceous period lasted from 136 to 65 million years ago. The hadrosaur in the broadcast lived during the late Cretaceous period—in fact, in the late part of the late Cretaceous period known as the Campanian stage.

Dinosaurs: Extinct land animals that lived on Earth between 225 and 65 million years ago, a period of 160 million years. (The term dinosaur is Greek for "terrible lizard," although now scientists believe they are only distantly related to lizards.)

Fossils: Remains of ancient life that are the basic sources of information to a paleontologist. Fossils can be bones, shells, or teeth (or impressions of these), impressions of plant stems and leaves, burrows, and tracks. Soft tissue is rarely preserved as a fossil.

Genus: A level of biological classification above the species and below the family level.

Geologic Time Scale: A system of dividing Earth's history into different periods based on significant events and the fossil content of the rocks.

Hadrosaur: A group of moderately large plant-eating dinosaurs that dominated North America in the late Cretaceous period at the end of the dinosaur age. Also called duckbills, hadrosaurs have flattened jaws that resemble those of ducks.

Hoodoos: Odd-shaped rock columns created by erosion.

Invertebrate: An animal that does not have an internal skeleton.

Matrix: In paleontology, the material that encloses the fossil. In the case of the hadrosaur in the broadcast, the matrix is the hard cement-like sandstone, which the scientists called the "entrapping matrix."

National Monument: A special tribute to a person or a place, designated by the Congress or the President.

Paleontologists: Scientists who study paleontology. They are "detectives" working with "clues," such as fossils, to reconstruct the history of the Earth and the plants and animals that have existed over millions of years.

Paleontology: The scientific study of Earth's past life (from the Greek *paleos+ontos+logos* = ancient life study). This study integrates biology and geology. Paleontology can answer questions about what plants and animals existed in a certain ancient time and how they interacted with each other and the land. Paleontology also can reconstruct the history of life and the Earth over millions of years.

Parasaurolophus: A large plant-eating dinosaur that lived during the Cretaceous period. This genus of dinosaur belonged to the family of hadrosaurs, or duck-billed dinosaurs, and was characterized by a long crest on top of its head. *Parasaurolophus* probably lived in small herds and fed on shrubs and other low-growing plants.

Permineralization: The process by which mineral crystals fill the hollow spaces in wood, bone, or shell. After an object undergoes permineralization, it is said to be permineralized. Even though permineralized fossils still preserve the original bone, tooth, etc., they look like rock and feel heavier than the original object because the spaces are filled with rock-forming minerals.

Plateau: A relatively elevated area of comparatively flat land that is commonly limited on at least one side by an abrupt land more than 150 to 300 meters (500 to 1,000 feet) above the adjacent country.

Sandstone: A hard rock formed primarily from layers of sand cemented together by other materials, such as silica, calcium carbonate, iron oxide, and clay.

Species: The basic unit of animal classification. A genus (plural: genera) includes one or more related species. Similar genera are placed into families.

Vertebrate: An animal with an internal skeleton of cartilage or bone.

Resources

"Albert's Excellent Adventure," BLM New Mexico's paleontology Web site:

http://www.nm.blm.gov/www/features/blm_paleo/blm_paleo.html

"Dinosaurs of the Colorado Plateau," BLM's electronic field trip Web site:

http://www.blm.gov/education/00_fieldtrip/index.html

Dinosaurs of Utah, by Frank DeCourten. Salt Lake City: The University of Utah Press, 1998.

Fossils on America's Public Lands Web site:

http://www.ut.blm.gov/recreationfossils.html

Fossils, Rocks and Time, Web brochure from U.S. Geological Survey:

http://pubs.usgs.gov/gip/fossils/

Heart of the Desert Wild: Grand Staircase-Escalante National Monument, by Greer K. Chesher. Bryce Canyon, UT: Bryce Canyon Natural History Association, 2000.

"High, Wide, and Windswept: The Colorado Plateau," by Bibi Booth, Richard Brook, Shelly Fischman, LouAnn Jacobson, Shelley Smith, and Mary Tisdale, in *Science & Children* (March 1999) and on the following Web site:

http://www.blm.gov/education/colplateau/

The Illustrated Encyclopedia of Dinosaurs, by David Norman. New York: Random House, 1988.

In the Presence of Dinosaurs, by John Colagrande and Larry Felder. Alexandria, VA: Time-Life Books, 2000.

Investigating Science with Dinosaurs, by Craig A. Munsart. Englewood, CO: Teacher Ideas Press, 1993.

"Paleontology Education Page," from the National Park Service, Florissant Fossil Beds National Monument, Florissant, CO. Web site features curriculum guide for teachers of grades 4-6:

http://www.nps.gov/flfo/4-6.htm

A companion site for teachers of grades 2-3 is available at:

http://www.aqd.nps.gov/grd/edu/guide1.pdf

"Paleontology: The Big Dig," Web site for children from the American Museum of Natural History, includes information on fossils, dinosaur discoveries in Mongolia's Gobi Desert, and interactive games:

http://ology.amnh.org/paleontology/index.html

Red Gulch Dinosaur Tracksite (BLM Worland, Wyoming Field Office) Web site:

http://www.wy.blm.gov/whatwedo/tracsite.new/rgdt_new.html

Seismosaurus: The Earth Shaker, by David D. Gillette. New York: Columbia University Press, 1999.

"Set in Stone," by Harley Armstrong, Carl Barna, Richard Brook, Mike O'Neill, and Mary Tisdale, in *Science & Children* (November/December 1997) and on the following Web site:

http://www.blm.gov/education/00_resources/articles/paleo/index.html

University of California, Museum of Paleontology Web site includes online exhibits, as well as classroom resources on geology, fossils, and evolution:

http://www.ucmp.berkeley.edu/

Evaluation Form

Discovering Dinosaurs

The first 100 educators to complete and return this evaluation form will receive a free "Share the Adventure!" t-shirt.

Name____

School____

Address____

City, State, Zip Code____

Audience____

Number of students viewing the broadcast__________________________________

Grade levels in audience____

Students live in an area that is (check one or more) ___ urban ___ suburban ___ rural

Please rate the following from 1 (poor) to 5 (excellent), with 0 meaning "not applicable":

Technical

1.	Overall quality of satellite feed	1	2	3	4	5	0
2.	Video reception	1	2	3	4	5	0
3.	Sound reception	1	2	3	4	5	0

4. Did you view this program ___ live ___ videotape?

Program content and presentation

5.	Overall quality	1	2	3	4	5	0
6.	Learning objectives	1	2	3	4	5	0
7.	Adult host in studio	1	2	3	4	5	0
8.	Student hosts	1	2	3	4	5	0
9.	Pretaped video segments	1	2	3	4	5	0
10.	Museum of Northern Arizona segments	1	2	3	4	5	0
11.	Phoenix studio segments	1	2	3	4	5	0
12.	Graphics	1	2	3	4	5	0

Interactivity

13.	Quiz during program	1	2	3	4	5	0
14.	Online Web site	1	2	3	4	5	0
15.	Telephone questions answered on air	1	2	3	4	5	0

15a.	Did your class phone in a question? ___ yes ___ no						
16.	Faxed questions answered on air	1	2	3	4	5	0
16a.	Did your class fax a question? ___ yes ___ no						

Educator Guide

17.	Overall quality of content	1	2	3	4	5	0
18.	Received in time to prepare for broadcast	1	2	3	4	5	0
19.	Background information	1	2	3	4	5	0
20.	Activities	1	2	3	4	5	0
21.	Appropriate level of activities	1	2	3	4	5	0
22.	Resource list	1	2	3	4	5	0

Followup

23. As a result of the broadcast, do you intend to use any of the guide activities in your classroom? ___ yes ___ no

    If yes, identify which ones (use back, if needed).

24. Would you be interested in future "Share the Adventure!" broadcasts? ___ yes ___ no

    If yes, please list topics that would interest you.

25. What is the best time of year for these broadcasts?___ fall ___ spring

26. What were the strengths of the broadcast?

27. What were the weaknesses of the broadcast?

28. Were the learning objectives met?

29. What changes could make this a more useful event for future participants?

30. What is your overall impression of this broadcast?

Other comments (use additional pages, if necessary):

Thank you for completing this evaluation. Please return it to: Bureau of Land Management; Environmental Education and Volunteers; 1849 C Street NW, MS LS 406; Washington, DC 20240. You may also fax the evaluation form to BLM at 202-452-5199. (Reminder: A free t-shirt will be sent to the first 100 educators who return this form!)