United States Department of the Interior

NATIONAL PARK SERVICE
John Day Fossil Beds National Monument
HCR 82, Box 126, Kimberly, Oregon 97848
www.nps.gov/joda

Kid's Activities Information Sheet

Among the valleys and bluffs of the John Day Country is buried a spectacular fossil record, and archive of life throughout the Age of Mammals. Here scientists have unearthed revealing chapters of this record of land plants and animals extending back from 6 to 54 million years. Their work continues unabated, and the knowledge they yield will enrich and satisfy anyone's quest to understand prehistoric life.

The known fossil beds spread out over a 10,000 square mile area, with the national monument covering 20 square miles. Three widely separated units make up the park, the Sheep Rock Unit, Painted Hills Unit, and Clarno Unit, each with its own unique landscape and fossil history. All three units offer beautiful hiking trails, picnic areas, overlooks, interpretive exhibits, and colorful scenery. The Sheep Rock Unit is the location of the Thomas Condon Visitor Center, which features a popular fossil museum.

Over 100,000 people visit the monument each year, many wanting to find fossils on their own. *Fossil collecting within the monument boundaries is expressly prohibited*, as they are protected. To satisfy curiosity, one may see hundreds of specimens on display at the fossil museum. Museum talks by rangers help bring the fossils back to life.

Kids activities include ...

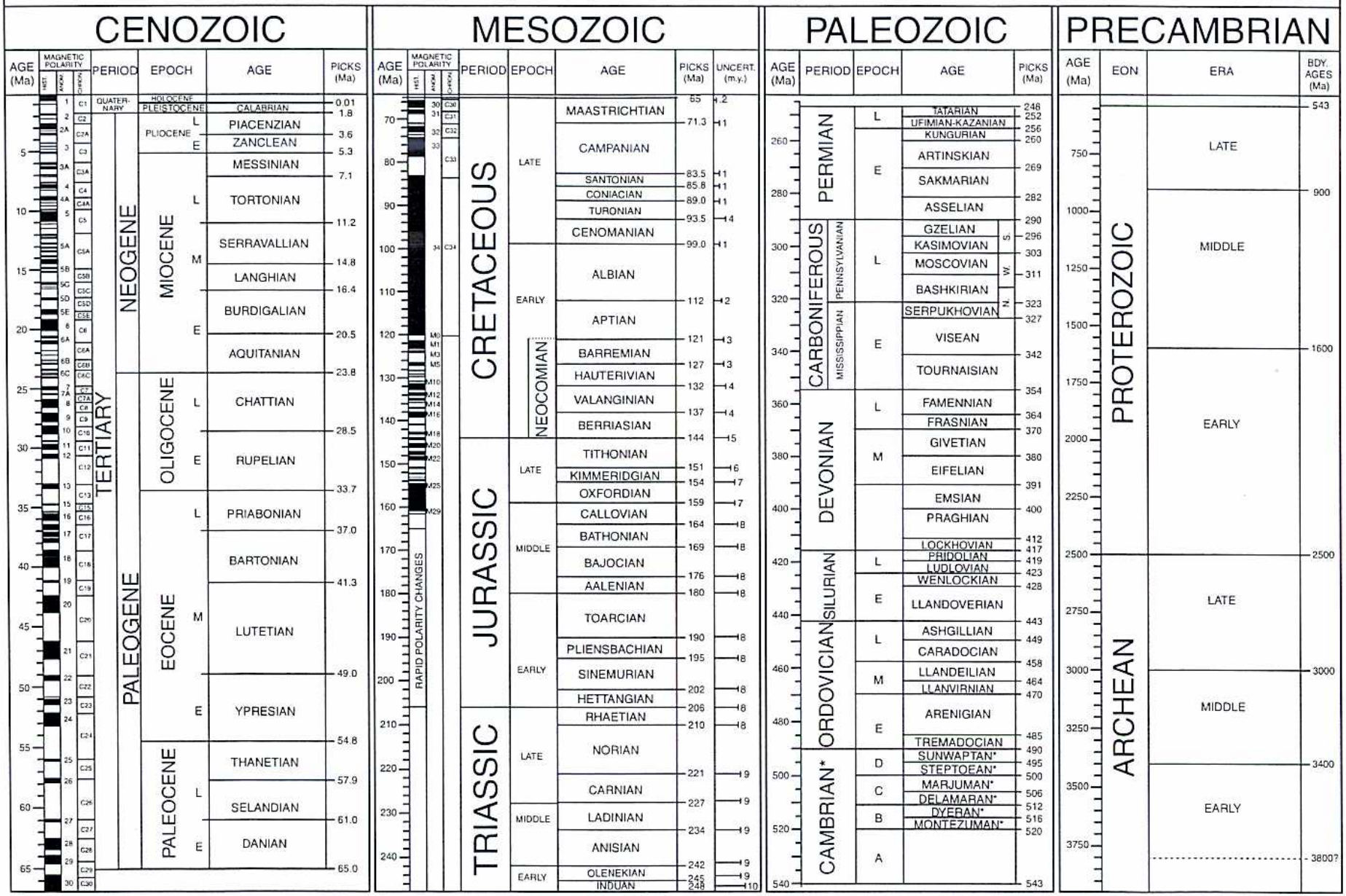
- Become a "Junior Park Ranger" by completing challenging activities that involve a quest for answers, exploring two of the three monument units. A handout is available at the visitor center, by mail, or refer to our web-site and complete the activity listed there. Junior Park Rangers receive a badge and certificate.

- Several short activities at the visitor center feature a scavenger hunt, matching games, and identifying hand-held fossils. Participants win buttons.

- Outside the monument boundaries, one can prospect for 33 million year old plant fossils at Wheeler High School, in the town of Fossil. You have an open invitation to explore their fossil bed and keep what you find.

For further information on John Day Fossil Beds National Monument please call (541) 987-2333, or visit our website at www.nps.gov/joda

1999 GEOLOGIC TIME SCALE



© 1999, The Geological Society of America. Product code CTS004. Compilers: A. R. Palmer, John Geissman

*International ages have not been established. These are regional (Laurentian) only. Boundary Picks were based on dating techniques and fossil records as of 1999. Paleomagnetic attributions have errors, Please ignore the paleomagnetic scale.

Sources for nomenclature and ages: Primarily from Gradstein, F., and Ogg, J., 1996, *Episodes*, v. 19, nos. 1 & 2; Gradstein, F., et al., 1995, SEPM Special Pub. 54, p. 95–128; Berggren, W. A., et al., 1995, SEPM Special Pub. 54, p. 129–212; Cambrian and basal Ordovician ages adapted from Landing, E., 1998, *Canadian Journal of Earth Sciences*, v. 35, p. 329–338; and Davidek, K., et al., 1998, *Geological Magazine*, v. 135, p. 305–309. Cambrian age names from Palmer, A. R., 1998, *Canadian Journal of Earth Sciences*, v. 35, p. 323–328.

GEOLOGICAL SOCIETY OF AMERICA

Major Geologic Strata

Ma = Millions of Years

From point A down to B, the layers of the John Day Fossil Beds are about three miles in thickness.

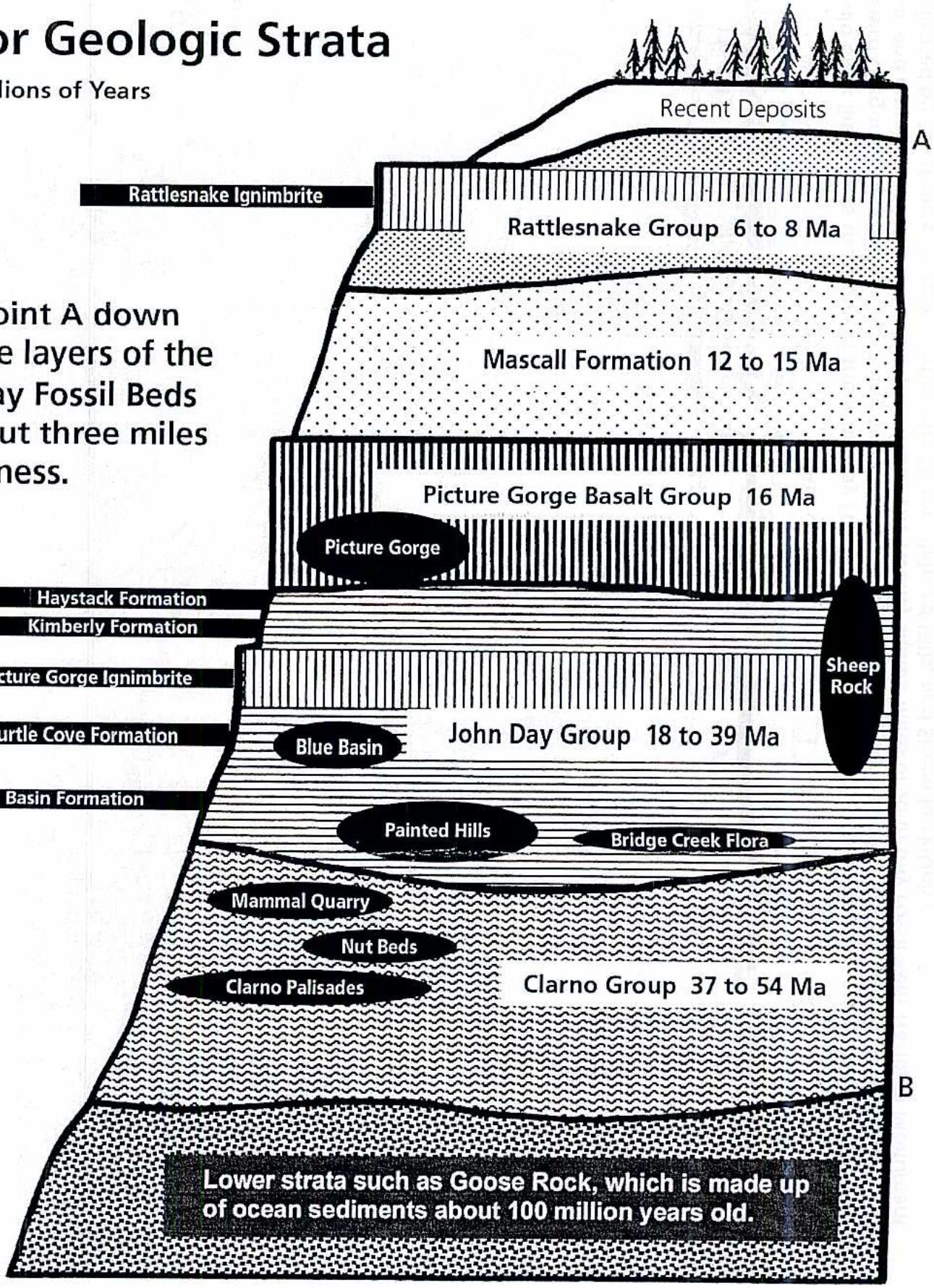
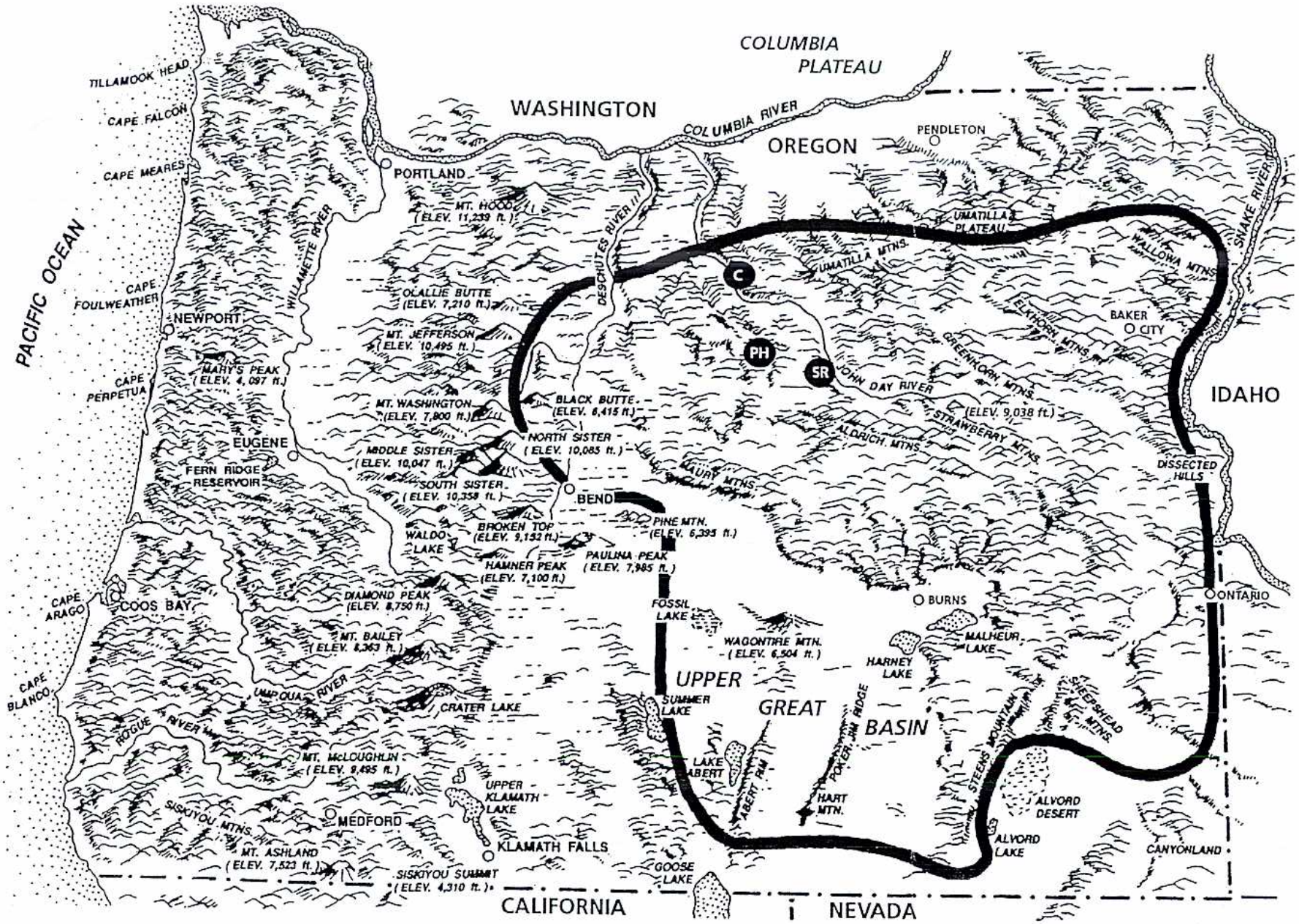


Diagram Not To Scale



The bold black line shows the scope of the John Day Fossil Beds study area as of 2005, spread out over 20,000 square miles of Eastern Oregon. About 50% of the study area is public lands, the destination of fossil researchers from the National Park Service, and museums and universities nationwide. The twenty square miles of John Day Fossil Beds National Monument are indicated by the three dots representing the Clarno, Painted Hills, and Sheep Rock Units.

While I was at the sheep Rock Unit.....

Draw a picture or write it down!

I saw:

I heard:

I smelled:

I felt:

I wondered:

Then- take your answers and make a poem or a story about your trip.

FOSSIL SCIENCE (explanations that may help you understand)

What is a fossil? ... Fossils are the remains or traces of animals or plants which have been preserved by natural causes in the earth's crust. In short ... *fossils are evidence of past life, preserved by geologic process.* Generally these geologic preservation processes take a long time, though some fossils have been found that are just several hundred years old. Some examples of fossils include a petrified (turned to stone) skull of a rodent, a petrified bird's nest, a seashell mold in stone, a carbon residue image of a leaf in stone, a canine's paw-print in rock, a stone cast of a beaver's burrow, and a frozen (intact) wooly mammoth in an ancient glacier.

What is the study of fossils called? ... The study of fossils is called paleontology. Paleontology is a branch of geology and biology. It is the science that deals with the history of the earth and its life as recorded in rocks. To understand how plants and animals lived in the past, one should learn about how they live now, so a paleontologist is also part biologist.

Where are fossils found? ... Fossils are found world-wide, from ocean deposits to the highest slopes of mountains, from Antarctica to the Sahara Desert. The type of sediments the organism was buried in is a key factor in the likelihood of fossils being present in any number. A key step in an organism's remains becoming a fossil is rapid burial by sediments. A land area in a period of erosion, rather than land building (heavy sedimentation), reduces the chances of fossilization. Each fossil site is different, in the types and numbers of fossil organisms found and how well they were fossilized. If you have seen one fossil park you have not seen them all.

How do fossils occur? (excerpts from, Prehistory, by Giovanni Pinna) ... The death of an organism is followed by complex fossilization processes (chemical, physical and biological). These processes maintain organisms in various degrees of preservation through time. When studying fossils it is always important to discover whether the fossil in question used to live in the place where it has been found or whether it was transported. "Post-mortem transportation" is very common, leading to organisms fossilizing in areas different from those in which they lived. Movement of remains can be caused by many factors; sea currents can move remains, floods move remains, scavengers can drag remains for short distances.

Disintegration processes may be the next fossilization phase. They act at different speeds on various organic parts of the remains. This disintegration can be due to three types of factors: biological, mechanical and chemical. Destructive biological agents, such as decomposing bacteria, generally affect the soft parts of an organism first. If the soft parts are to be preserved a rapid and thick sedimentation must take place and cover the organic remains before they are completely decomposed. Even shallow layers of deposits contain bacteria and allow decomposition. Other destructive biological agents include burrowing animals and scavengers.

Mechanical destruction can be caused by currents, waves, wind and other factors that produce abrasion and corrosion of an organism, sometimes destroying it completely. The combined action of destructive biological and mechanical agents is such that, more often than not, fossils are found to be incomplete, broken and scattered over a wide area.

Chemical dissolution is more destructive to an organism's soft parts, which are made up of carbohydrates and proteins. It has less effect on the hard parts, composed of calcium carbonate, calcium phosphate, silica, or highly resistant organic substances such as chitin, keratin, and

cellulose. Chemical change plays an important role, since it can continue to affect the organism even after they are already fossilized. Even within the same organism, certain parts are found to have fossilized and others to have vanished, since different structures react quite differently to chemical corrosion. In mammals, for instance, teeth are more easily preserved than bones. They are more resistant to dissolution.

Finally, a lot depends on the type of sediment which has surrounded the organism. Generally speaking, coarse sediments (such as sand, conglomerates and gravel, easily infiltrated by water) do not lead to a good preservation of organisms. Fossils are rarely found in such rocks. On the other hand, clays, marl (high in calcium) and all impermeable sediments, primarily fine-grained, are better suited to give the necessary protection and are therefore found to be rich in fossils.

Water, rich in dissolved mineral salts, circulates in sediments. It can effect organisms embedded in the sediments in two ways: they tend to dissolve the organic remains, while at the same time they impregnate the organism with mineral substances, thus stabilizing it and preserving it. The slower the water circulation the better chance of an organism being saturated with minerals and preserved, called mineralization or petrification. The substitution of organic matter with inorganic mineral substances can be total, such that all the hollows in an organism which had organic matter are filled by minerals. A more interesting process is molecular substitution. It consists of the substitution of each and every organic molecule, and can preserve minute details of organisms. An example of this process is fossilized wood which still shows the growth rings.

Under certain conditions, or due to an unusual combination of factors, organisms have been preserved as fossils in very unusual ways. Common in rocks are molds, imprints, and casts of organisms, whose remains have dissolved away with time. Carbonized fossils, affecting mainly plants, are due to the action of certain bacteria which attack the plant remains, eliminate oxygen and nitrogen and indirectly add carbon. Though the plant material is gone the carbon residue remains, leaving dark images in the rock of the parent organism. Tree resin can trap and preserve intact small insects, the resin polymerizing into amber over time. Rare cases of mummification result in fossils having undergone a thorough dehydration process. This can result in the total conservation of even the most delicate parts, such skin and tendons. Also ancient glaciers have trapped and frozen organisms, intact. Though there are many different types of fossils, finding mixtures of these types in the <u>same</u> earth strata would be extraordinary.

What assumptions do we make when we study earth's history? (excerpts from, <u>Evolution of the Earth</u>, by Robert H. Dott, Jr., and Donald R. Prothero) ... The idea of some sort of uniformity in nature through time is absolutely basic to the analysis of earth history. Modern geology sees the earth as evolutionary and having changed through an irreversible, or evolutionary, chain of cumulative events. The only assumption that we make today is that *the principles of nature have been uniform through time*. We hasten to stress that this uniformity is an assumption that we make about nature and so is a *doctrine* rather than a logically proven law."

We do not assume that the geological processes (this is different from principles) always acted with the same rates and intensities. Floods, erosion, volcanic eruptions, mountain uplifting, wind and seas currents, continental drift, all occur with varying rates and intensities. Another way of stating the principle of uniformity is that "the present is the key to the past." Paleontologists utilize the principle somewhat in reverse. Future predictions may be made from observations about the past. This concept has been cited as the basis for the study of history in general. We may be able to predict the future of modern lifeforms by studying the fossil record. 9/00

What is Paleontology?

OBJECTIVE: To introduce students to the concept of paleontology, the definition and types of fossils, as well as understand that ancient ecosystems were just a complex as the world around them today.

BACKGROUND: Paleontology is the study of ancient life. Ancient is typically defined as greater than 10,000 years old. To study paleontology scientists look at fossils or preserved remains or evidence of a plant or animal that lived more than 10,000 years ago. This activity will explore the different ways that our world may be preserved and turned into fossils.

MATERIALS:
- Classroom window
- Hand microscopes
- Pictures of ecosystems throughout the world
- Fossil specimens (kit available through John Day Fossil Beds Nat'l Monument)

DISCUSSION:

I. *Define Paleontology and Fossils*

Spread the fossils out in the classroom or have the students pass the fossils around. Just before the fossils are passed out, let the students know that they are fossils but do not provide a definition. After they have looked at a few, ask them to keep looking at the samples and come up with a definition for fossils. Discuss what fossils are by adding or modifying what the students have discovered and what paleontologists do.

Note: What is the difference between an archaeologist and a paleontologist? A paleontologist studies any ancient life older than 10,000 years; whereas, an archaeologist studies the effects of or the remains of human origin. Although this area may slightly overlap (the study of humans and ancient life) in general human settlements or remains have not been found much older than 10,000 years old.

II. *Conditions for fossilization*

What conditions are needed for fossils to be preserved? For plant or animal remains to be preserved, they must be sealed off from surface conditions. What would different surface conditions do cause plants or animals to decay?

Oxygen: the presence of oxygen in the atmosphere means that plants and animals will slowly decompose. The carbon in the cell structure will combine with atmospheric oxygen to form carbon dioxide. The chemical process is the same as combustion.

Scavengers: Scavengers like turkey vultures, raccoons, coyotes, and crabs will eat the remains of plants or animals and so keep the plant or animal from fossilization.

Note: The type of material that can be fossilized depends on how destructive the method of fossilization is. For example, a mudflow is quite powerful. Force is mass multiplied by acceleration. The mass of a mudflow is tremendous compared to that of water. The force of the mudflow or of the avalanche will destroy some potential fossils while preserving others. Another example is for marine fossils. In a quiet bay, you might find mollusks preserved in the rock, relatively like they were living. The sedimentation process is slow and gradual not disrupting or destroying the habitat of the ancient creatures. If you come across a rock that has a jumble of mollusk parts thrown together, broken, and scattered then the energy of the environment was higher. In other words, the waves were stronger and did not allow the mollusks to be buried without disruption. One clue about the ancient past is the way in which the fossils are preserved.

III. Types of Fossils

Once the conditions for fossilization are better understood, have the students think about different types of fossils that they might find. To do this, have the students investigate the schoolyard outside, what materials that they find out there might be turned into fossils? In other words, what are the clues that they see that life is present? This could be easily tied in to a tracking class where the students relate the types of tracks, scat, and other characteristic signs of an animal with the world around them. Anything that the students see that are signs of animals today, may become fossil tomorrow.

Freezing: Some animals or plants may be preserved with little or no change through freezing. Freezing is amazing because soft tissue is still preserved. Mammoths and other animals from the Pleistocene (1.7 millions years ago to the present) have been saved from decay and scavengers by being buried in ice.

Desiccation or drying: Have your students ever found a dried out toad? We can find desiccated animals around here, generally after having been squashed. These desiccated animals are generally of not much interest to scavengers and so may be preserved in the earth.

Imprint Fossils: More fragile materials like leaves may be preserved long enough to have an imprint made of the original organic material. The leaves found in the ancient lake deposits had been imprinted in the fine-grained mud, silt, and clay.

Chemical Preservation: Example of chemical preservation occurred at Rancho La Brea tar pits. Tar, peat bogs, or oil seeps chemically preserve the animal as it fell into the preserving agent.

Permineralization: Permineralization is the process by which a fluid full of dissolved minerals seeps through a buried organisms and enters the empty spaces in the cells. Mineralization occurs when the dissolved minerals actually

FOSSILIZATION AND ADAPTATION ACTIVITIES IN PALEONTOLOGY

BRENT H. BREITHAUPT

INTRODUCTION

AS THE concepts of time, past life, and fossils are often difficult for children to comprehend and as many of the National Parks and Monuments have important paleontological resources, Fossil Butte National Monument developed a fossil education curriculum guide designed to aid teachers presenting these principles to students in the second and third grades. The following activities are modified from that guide (Leite, M. B. and Breithaupt, B. H., 1994, Teaching Paleontology in the National Parks and Monuments: A curriculum guide for teachers of the second and third grade levels: National Park Service, Fossil Butte National Monument, Kemmerer, WY 103 p.). For more information on this curriculum guide distributed though the National Park Service, please contact Ms. Marsha Fagnant, Fossil Butte National Monument, P.O. Box 592, Kemmerer, WY 83101.

OVERVIEW

How does a living thing become a fossil? The mysterious processes by which evidence of past life is preserved are explored in these exercises. By thinking about and participating in some simulated sedimentary processes, children will be able to remove much of the mystery behind fossils and fossilization. These exercises introduce the concept that fossils are remains or traces of ancient living things. They will also begin to think about how rare an event fossilization is.

Objective: After completing these exercises students will be able to: evaluate the importance of fossils to our knowledge of past life; identify conditions necessary for fossilization; construct a possible scenario for formation of fossils; understand how organisms are adapted to their environments; and understand the relationships of modern and ancient communities with their environments (i.e., ecology and paleoecology).

ACTIVITY I: FOSSILIZATION

Message: Not all parts of animals become fossilized. It may not be possible to know some details of what an ancient animal or plant was like because many parts of the anatomy may not become fossils.
Materials: Drawings of horse and *Stegosaurus* skeletons. (Figures 1 and 2)
Discussion: Fossilization is a rare event. The chances of a given individual being preserved in the fossil record are very small. Some organisms, however, have better chances than others because of the composition of their skeletons or where they lived. This also applies to the various parts of organisms. For example, plants and vertebrates (animals with bones) are made up of different parts that can separate after death. The different parts can be transported by currents to different locations and be preserved separately. A fossil toe bone might be found at one place and a fossil rib at another location. We could assume that they are from different animals when, in fact, they came from the same one.

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Much information is lost in the fossilization process. Think, for example, of a vertebrate (such as ourselves). Much of what we consider important about our own 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 (there are exceptional cases where soft parts are preserved). Bones and teeth are not always preserved together. This exercise is designed to get children to think about the quality of information that comes from the fossil record.

Procedures:

1) List facts about a living animal. The skeleton of a horse is used here, but there are many other possibilities (e.g., cow, dog, cat, sheep). 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) What would we know if this animal was extinct ? Refer to the diagram (Figure 1) and point out an important generalization of fossilization: most of the time, only the hard parts (bones and teeth) are preserved as fossils. Go through the list and ask the class what we would know about the horse if horses were extinct and all we had were fossilized bones and teeth of horses. We would know that it was a large animal and could probably make some good guesses about its weight. We would know that it had grinding teeth and therefore could probably guess that it 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 it had hooves. The skeleton would also be useful to tell us that it was a fast runner. But no details of the hair or skin would be known. Everything about social behavior and vocalization would also have to be guesses.

3) What do we know about fossilized animals? Pass out the diagram of the fossil *Stegosaurus* (Figure 2) and interpret it in light of what we do know. Use the list you made in discussing the living animals. What paleontologists know comes from studying the hard anatomy, in this case bones and teeth. Anything else is a guess, although in most cases it is possible to base the guess on sound biological principles.

4) Use your imagination. As a summary to this exercise, have the class put muscles and skin on the diagram of *Stegosaurus*. Remember, skin color and texture are largely the choice of the artists, since fossil bones are of no help, although some skin impressions have been found.

ACTIVITY I / VARIATION I: Specializations

Both the horse and *Stegosaurus* have some bones that are not shared by the other. That is because each is specialized in some way. The horse is adapted for fast running, and therefore its feet have become specialized for running. They are simpler than those of *Stegosaurus*, with only one toe bone on each foot. Horses also have very specialized grinding teeth, while the teeth of *Stegosaurus* are simple slicing structures. *Stegosaurus*, on the other hand, has some very spectacular specializations in its huge armor plates and tail spikes. Some specializations of *Stegosaurus* are for defense because it was not a fast runner. What other differences between the horse and can you find? Can you think of a possible adaptation for these bones?

ACTIVITY I / VARIATION II: Imaginary Creatures

Draw a picture of a made-up creature with adaptations for a special way of life. Examples: a fast flier that eats leaves from the tops of trees; a burrowing animal that digs holes so fast no other animal can catch it. Describe how this animal is special and how it accomplishes what it does. Could paleontologists find out about this way of life from the fossil record?

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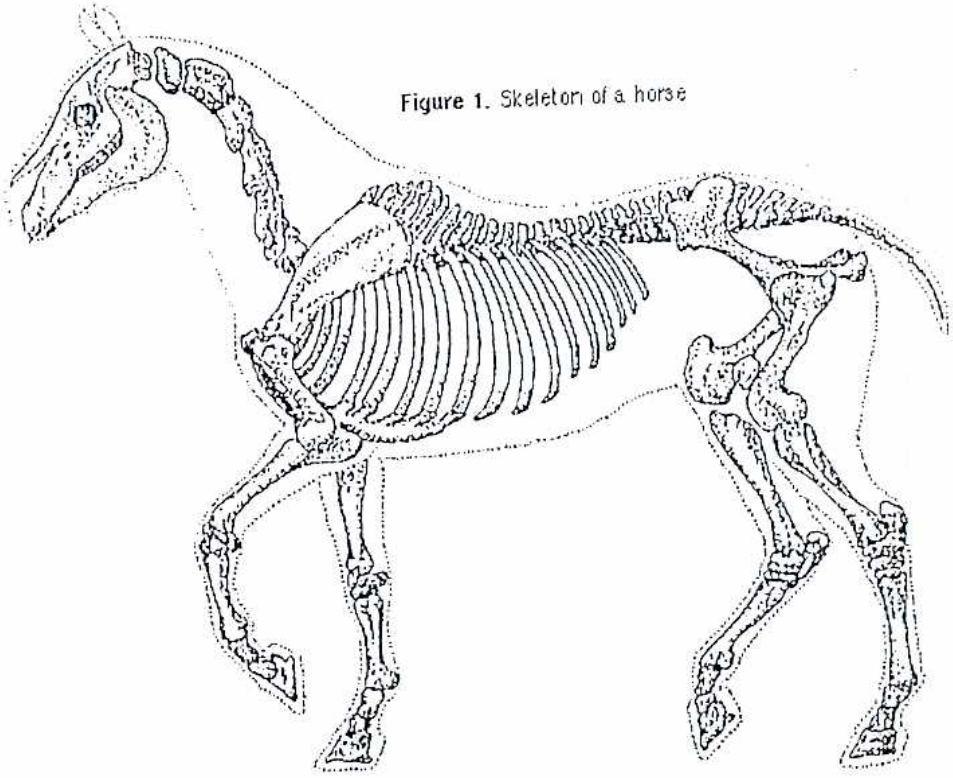

Figure 1. Skeleton of a horse

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Figure 2. Skeleton of a *Stegosaurus*

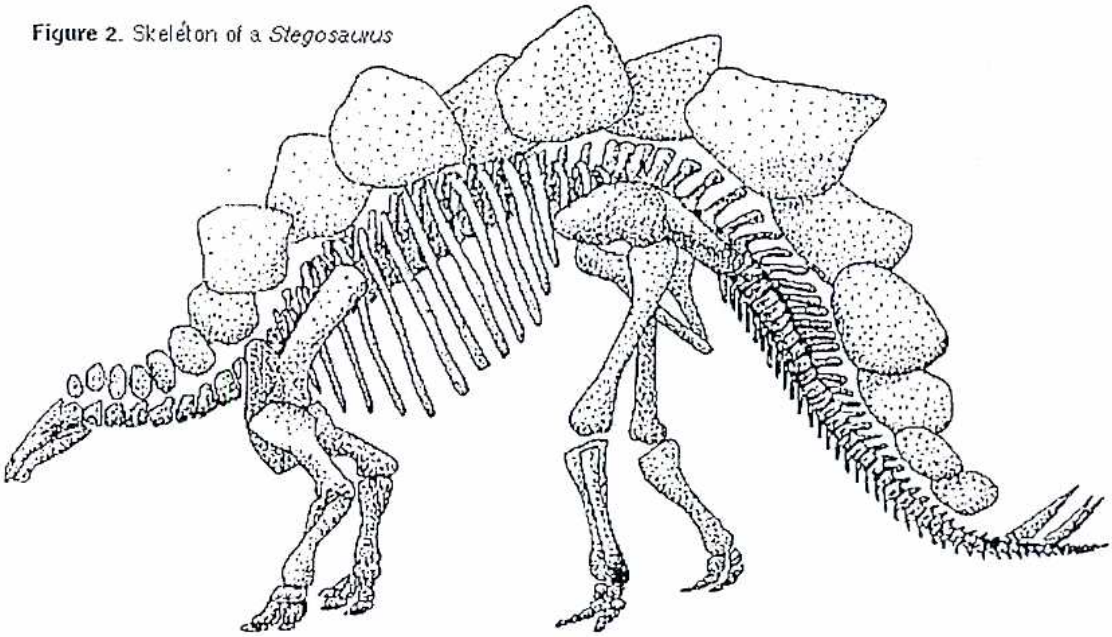

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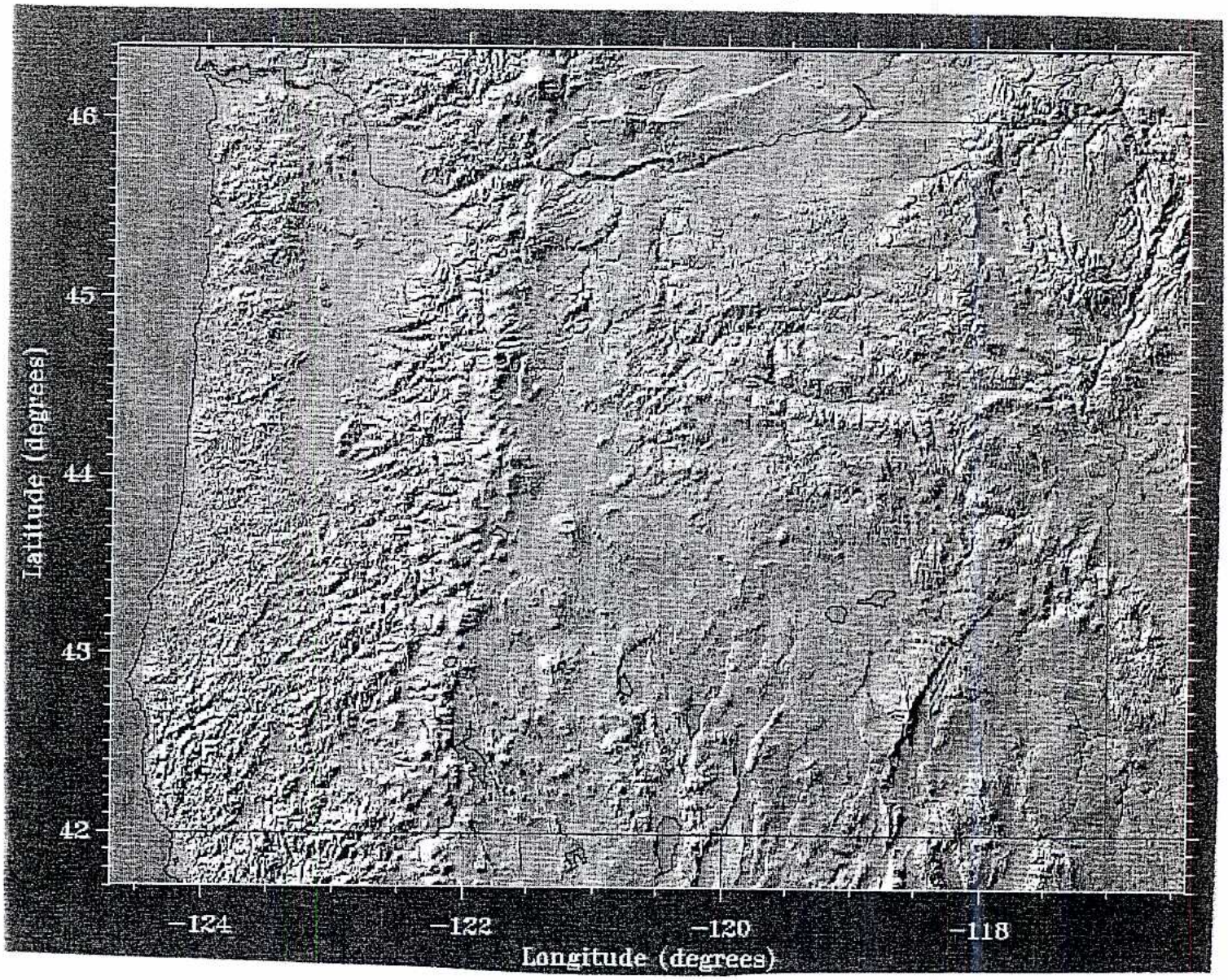
Figure 3. Fossilization cards

Where In Oregon Am I ?

A. **Ask the ranger for a pencil and ruler to help you locate the following places in Oregon.**

B. **Draw an X on the exact location on the map for each of the these six places.**

1. 44.6 degrees Latitude by -119.6 degrees Longitude – John Day Fossil Beds National Monument Visitor Center
2. 45.6 degrees Latitude by -122.7 degrees Longitude – Portland
3. 42.95 degrees Latitude by -122.1 degrees Longitude – Crater Lake
4. 44.3 degrees Latitude by -118.7 degrees Longitude – Strawberry Mountain
5. 43.75 degrees Latitude by -121.2 degrees Longitude – Newberry Crater
6. 45.4 degrees Latitude by -121.7 degrees Longitude – Mt. Hood



Why is Your Name So Long, Little Fossil?

Scientific names of fossil plants and animals may be long and tricky to read. But if you know the English meanings of the Greek and Latin words, they all begin to make sense. Right here in the John Day Fossil Beds Museum are some specimens with descriptive scientific names. See if you can figure out the name of the fossil described in each clue below. Use the exhibits and the Greek and Latin word list to find the answers!

Example: If you were looking for the scientific name for a **lesser horse**, you could deduce the answer by looking at the word list for "lesser" and "horse" and looking at the exhibits cases and pictures for a smaller horse. It's *Miohippus*!

1. Who has **teeth** shaped like **mountain** ridges?

2. Who was "**father** of the **cats**?"

3. Which fossil skull belonged to a **beast** with **two horns**?

4. What **beast** was so big that it may have made the ground shake like **thunder**?

5. Which plant fossil is named for the **bristly** part of a **horse**?

6. What animal's **teeth** were so long that they covered its chin like a **beard**?

All Greek (or Latin) to You?

Here are the English meanings of some common root words used in scientific names.

bronto:	thunder (Greek)
ceras:	horn (Greek)
di-:	two (Greek)
don (dont):	tooth (Greek)
equus:	horse (Latin)
felis:	cat (Latin)
hippos:	horse (Greek)
lophos:	crest (Greek)
mio:	less (Greek)
oros (oreios):	mountain (Greek)
patrio:	father (Latin)
pogon:	beard (Greek)
saetum:	bristle (Latin)
tetra:	four (Greek)
therium:	beast (Greek)
zyga:	joined (Greek)

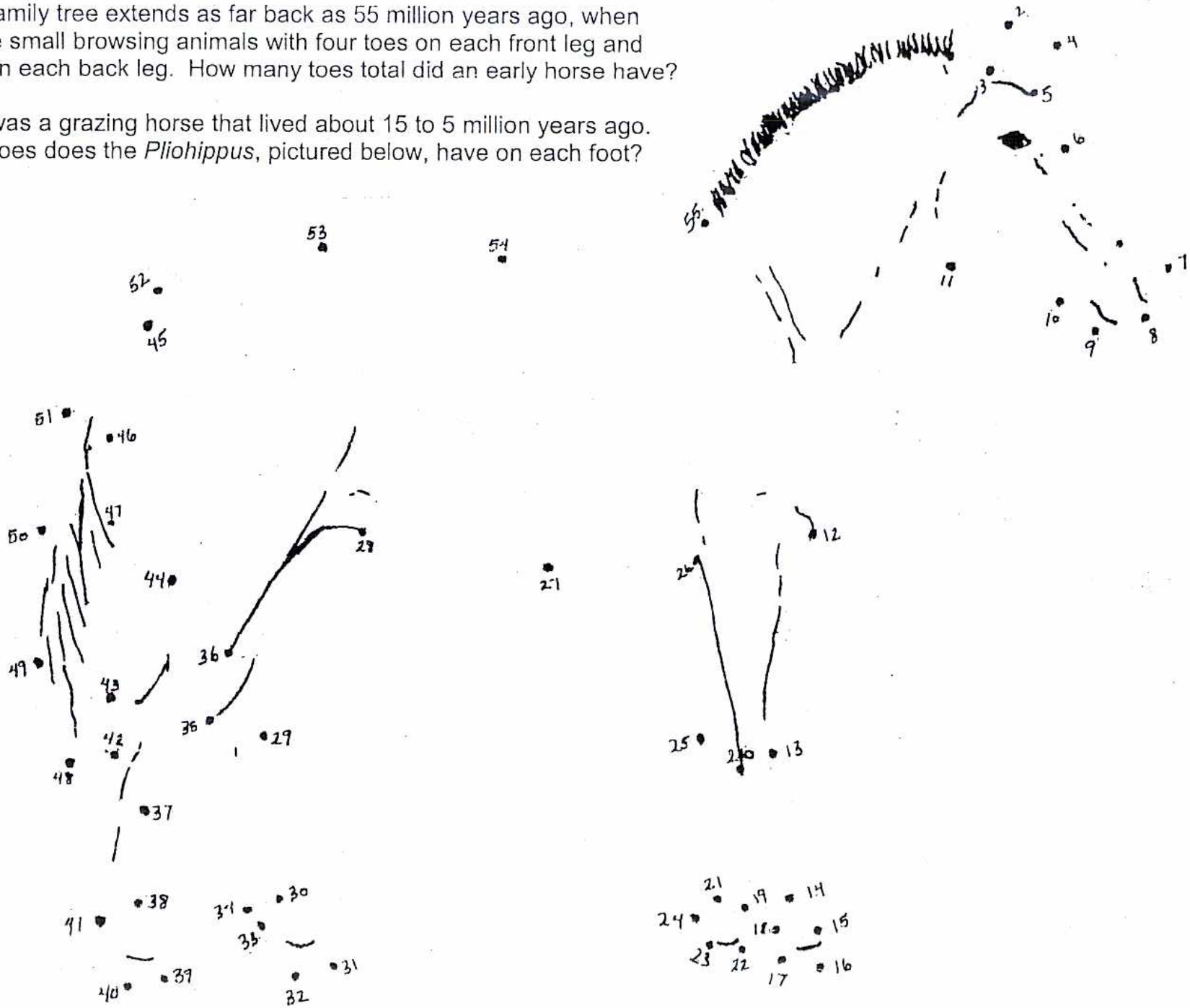
7. In the exhibit cases, find the teeth from two elephant-like creatures. Which animal's **teeth** had **joined crests**?

   Which animal had **four crests** on each **tooth**?

Horses Have Toes?

The horse family tree extends as far back as 55 million years ago, when horses were small browsing animals with four toes on each front leg and three toes on each back leg. How many toes total did an early horse have?

Pliohippus was a grazing horse that lived about 15 to 5 million years ago. How many toes does the *Pliohippus*, pictured below, have on each foot?



Fossil Word Search

Using the list at the bottom of the page, find the names of some of the fossils discovered in the John Day Fossil Beds. They may be horizontal, vertical, diagonal or backwards. Some letters may be used more than once.

Good luck!

D	T	U	S	U	L	I	M	S	U	E	H	K	R	W	V	L	A	E	M	I	B	C	W	K	O
H	U	E	S	L	P	S	J	R	Y	M	Q	L	E	E	I	N	H	P	A	A	K	J	B	D	G
L	N	K	B	U	V	E	M	T	N	O	D	O	E	R	O	S	F	C	Z	Y	P	U	O	Q	B
B	G	T	U	H	B	V	I	D	R	I	J	B	X	S	W	O	K	M	Z	Q	P	L	L	A	J
C	G	Y	U	F	J	S	O	T	K	U	A	R	B	K	I	Y	S	S	G	J	B	K	E	S	R
S	I	O	M	E	I	Y	H	R	J	E	P	U	L	E	Y	O	L	M	S	R	S	I	I	K	G
U	M	I	O	Q	H	Q	I	F	S	T	E	U	S	P	N	D	R	O	O	Y	X	A	T	E	M
L	F	S	W	U	J	P	P	O	G	O	N	O	D	O	N	R	K	N	L	I	V	A	G	L	P
U	C	E	M	I	A	L	P	P	K	A	T	E	P	Q	S	T	T	T	H	E	D	E	T	U	L
G	Q	L	A	S	M	Z	U	H	E	L	M	G	J	Q	P	O	X	V	M	B	E	S	K	J	I
A	P	X	N	E	K	O	S	W	N	S	C	B	J	I	T	R	S	F	H	B	L	S	R	H	O
R	C	A	P	T	Z	E	T	D	T	D	L	A	H	H	E	Q	T	O	R	B	I	F	J	J	H
T	I	C	T	U	A	N	E	I	E	J	C	R	E	O	B	I	N	S	F	O	D	N	P	I	I
R	R	H	H	M	C	L	T	E	L	O	T	R	Y	S	A	E	O	S	I	E	O	L	K	C	P
E	I	A	S	T	D	M	A	S	O	H	E	I	H	S	A	G	D	O	N	I	C	O	D	A	P
P	A	P	R	A	T	N	A	C	D	N	E	I	J	I	H	A	O	F	D	M	O	O	F	Y	U
Y	N	M	C	J	E	N	C	H	O	P	E	N	G	J	N	S	E	E	E	L	R	Z	R	H	S
H	A	A	E	C	F	G	I	L	N	S	D	F	I	E	D	O	R	I	I	W	C	O	H	O	S
C	V	N	U	E	A	P	W	L	T	A	Z	C	B	H	R	W	C	H	D	Y	P	E	R	T	R
V	I	R	T	J	A	M	E	T	A	S	E	Q	U	O	I	A	W	E	E	P	I	H	O	P	G
C	S	A	H	I	L	L	E	S	D	M	E	R	F	F	R	I	E	U	R	A	L	E	V	E	L
I	L	K	E	R	S	T	Y	L	E	M	Y	S	H	R	L	T	I	O	N	O	C	H	S	N	U
E	Q	R	T	V	N	H	E	U	D	M	I	L	L	L	F	B	O	G	S	I	S	E	R	G	M
E	L	B	T	A	M	X	Y	R	E	M	O	M	O	R	D	J	B	C	E	H	Y	E	O	P	L
F	R	O	S	G	P	H	A	M	T	E	L	W	V	R	A	I	T	N	O	D	O	N	Y	M	A
R	M	I	N	I	M	R	A	V	U	S	K	J	P	W	R	E	S	T	U	J	F	L	M	X	P

METASEQUOIA
PALM
HYPERTRAGULUS
ENTELODONT
POGONODON
CAMEL
STYLEMYS
AMYNODONT

EUSMILUS
WILLOW
ELM
PLIOHIPPUS
OREODONT
NIMRAVUS
BRONTOTHERE

CROCODILE
MIOHIPPUS
MAPLE
EQUISETUM
CREODONT
DROMOMERYX
RHINOCEROS

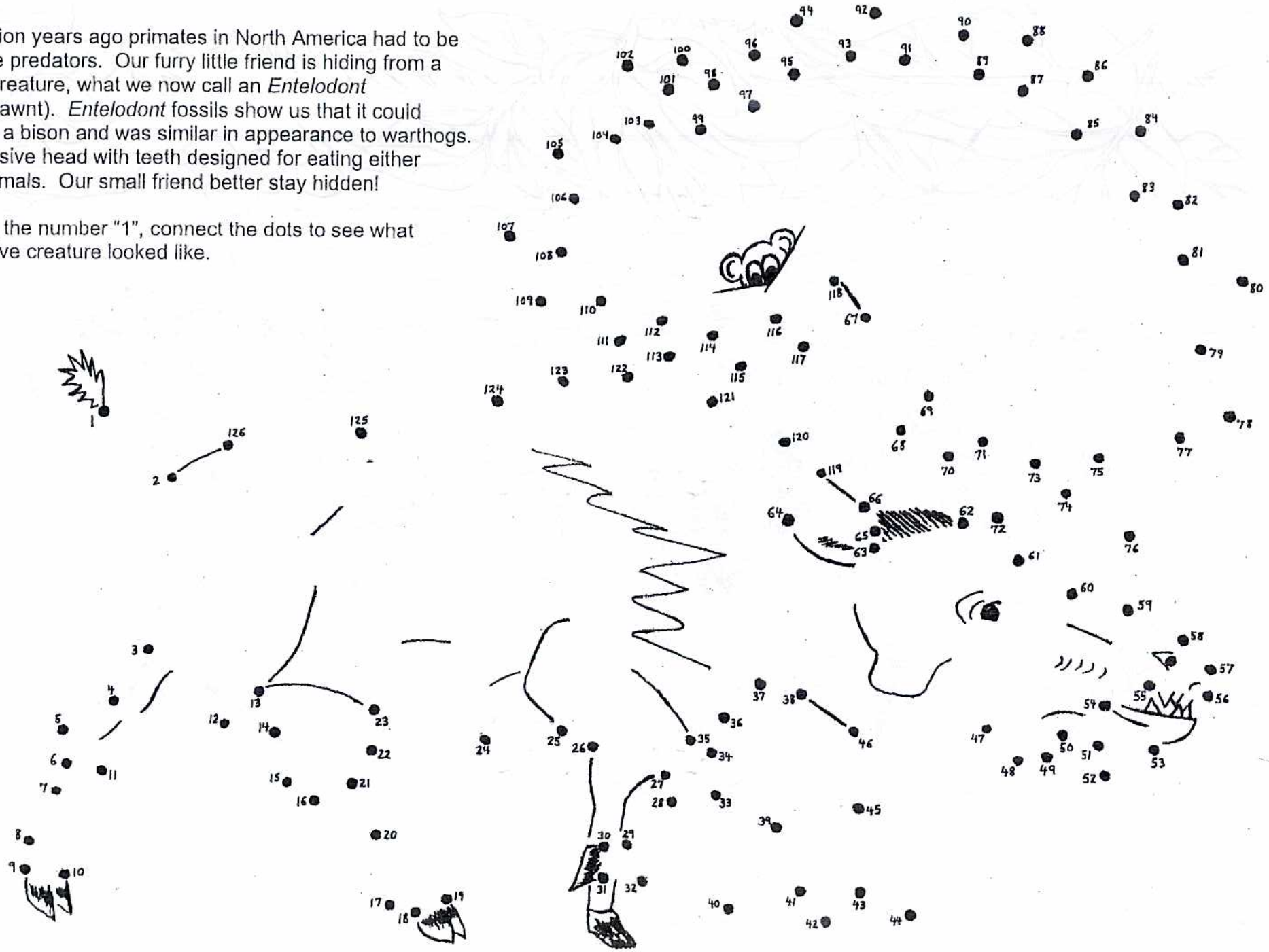
Produced with Visitor Donations

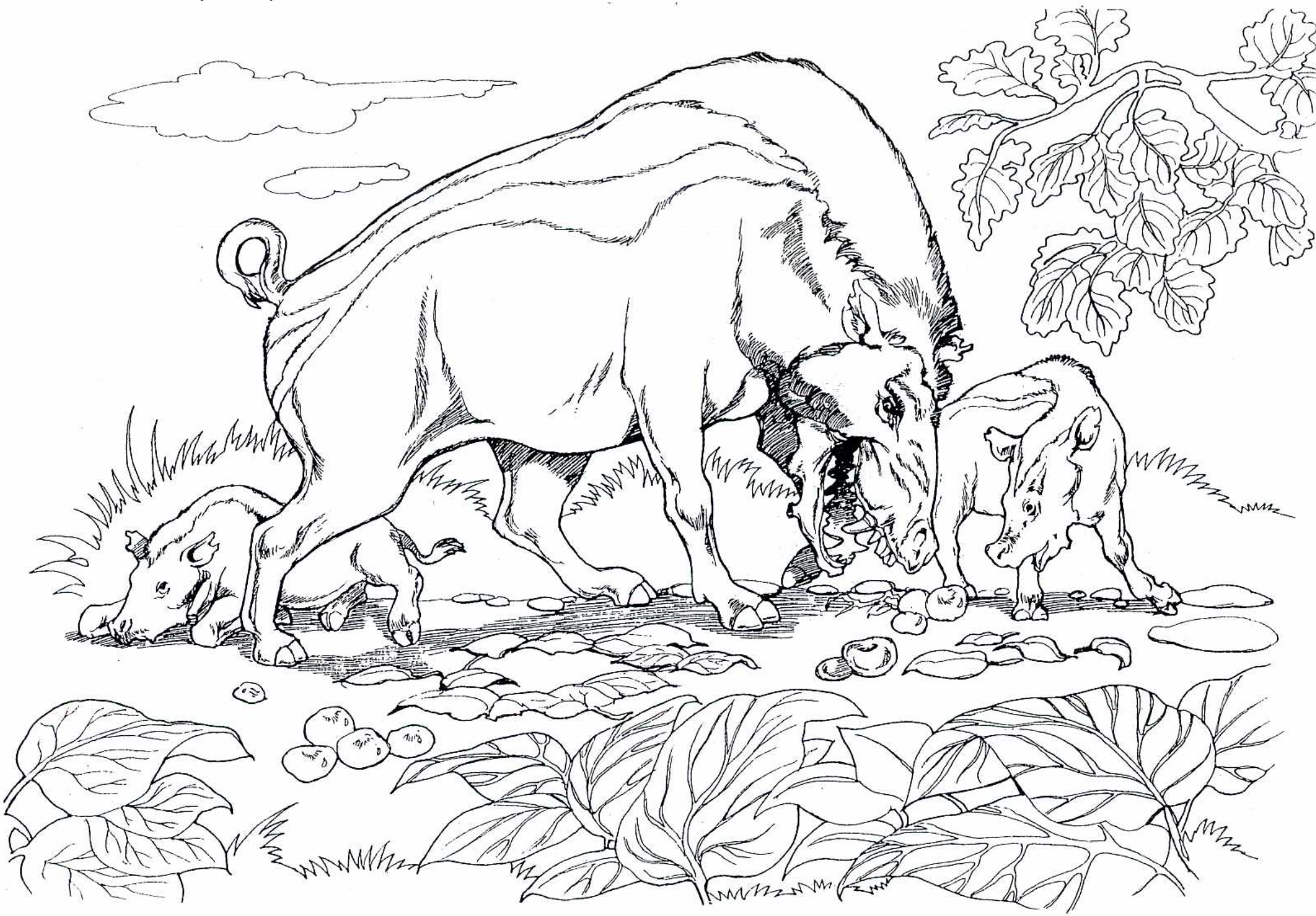
The John Day Fossil Beds National Monument,
James Cant Ranch Visitor Center, in Oregon - **COLOR ME**

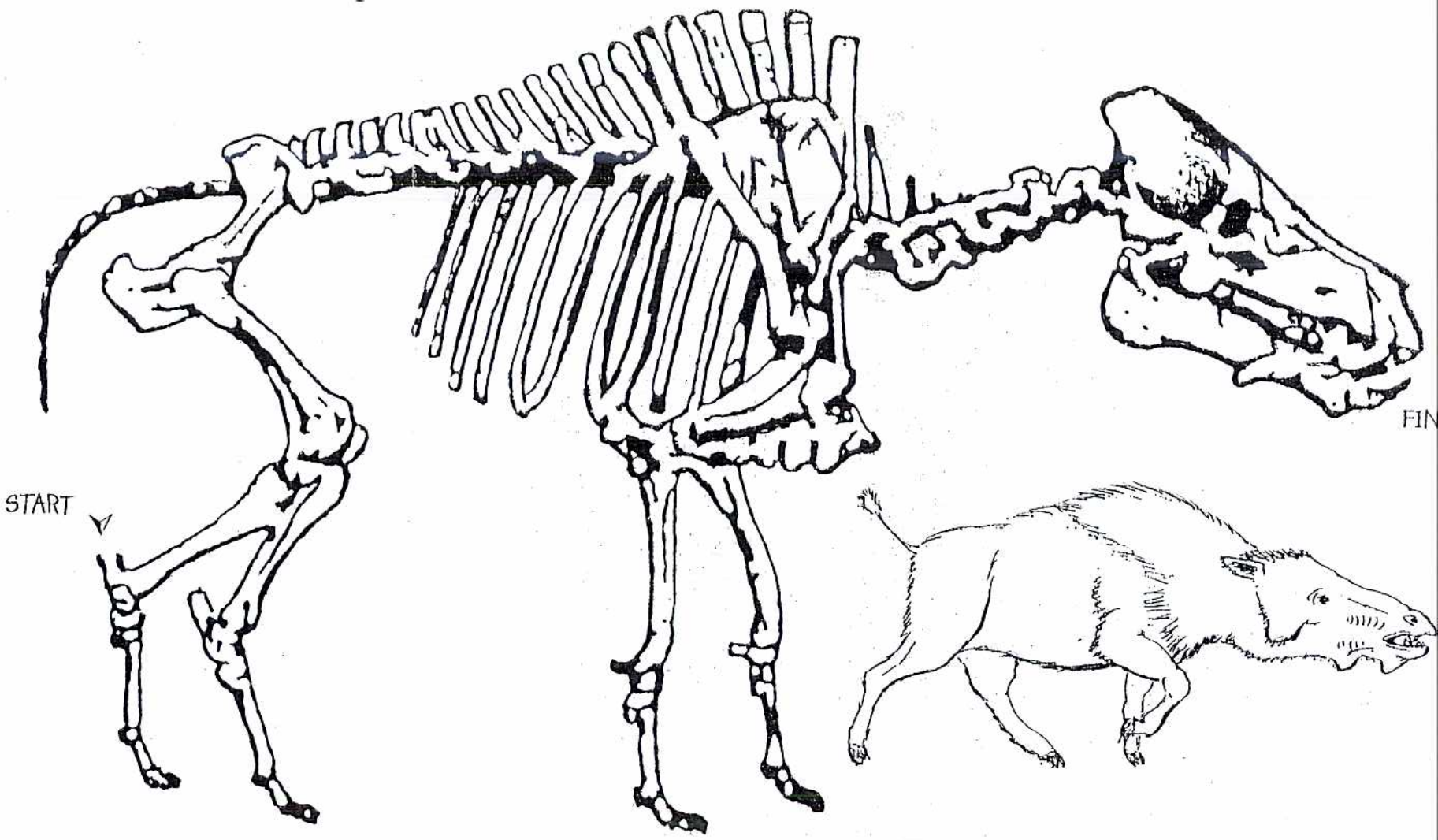
Watch Out !!!

Even 30 million years ago primates in North America had to be wary of large predators. Our furry little friend is hiding from a dangerous creature, what we now call an *Entelodont* (n-TEAL-o-dawnt). *Entelodont* fossils show us that it could be as big as a bison and was similar in appearance to warthogs. It had a massive head with teeth designed for eating either plants or animals. Our small friend better stay hidden!

Starting with the number "1", connect the dots to see what this impressive creature looked like.







The entelodonts were a family of animals related to pigs and hippopotami. About the size of a bison and armed with a fierce array of teeth, these giants probably feared few enemies. Like modern pigs, entelodonts were omnivorous. They probably ate roots and foliage as well as any animals unlucky enough to stray into their path. See if you can find your way through the skeleton of the entelodont without getting eaten!

Produced with Visitor Donations

The Painted Hills Unit Questions:

1. At the picnic area, the date printed on the "The Dalles – Canyon City Military Road" map is:

2. Who was the minister who "recognized the value of Captain Drake's fossil discovery"?

3. At the Painted Hills Overlook, what does the exhibit say about the world famous Bridge Creek Flora fossils?

4. What buried this area layer by layer?

5. Along the Leaf Hill Trail there are several exhibits. What did the famous paleobotanist Ralph W. Chancy discover when he studied the area in the 1930's?

6. What type of rock were the fossil specimens found in?

How Is Your Latitude Today?

The map to the right shows the planet's landforms as they appear today. Can you label the other maps showing the landform positions in the past?

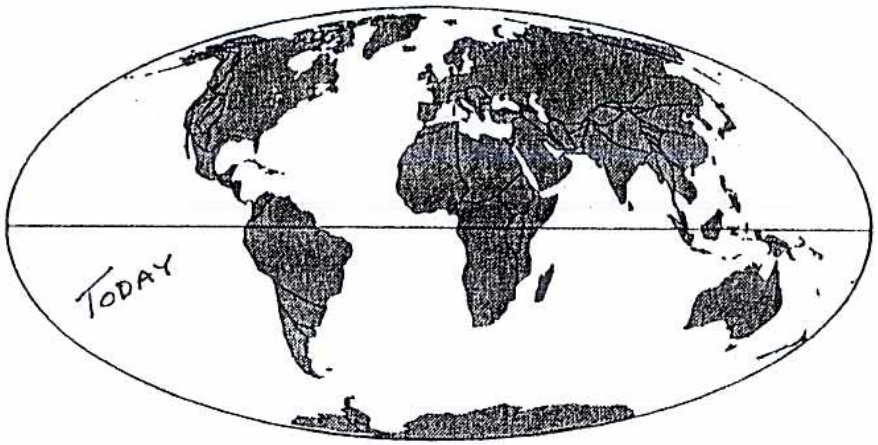
Which one is 80 million years ago?

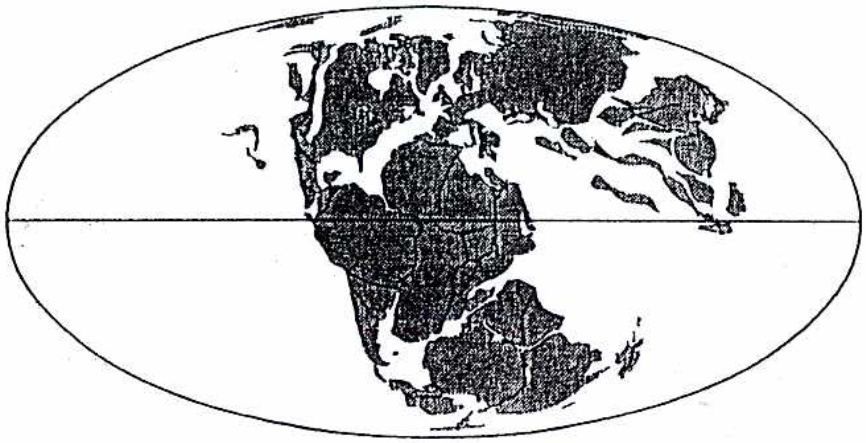
Which one is 160 million years ago?

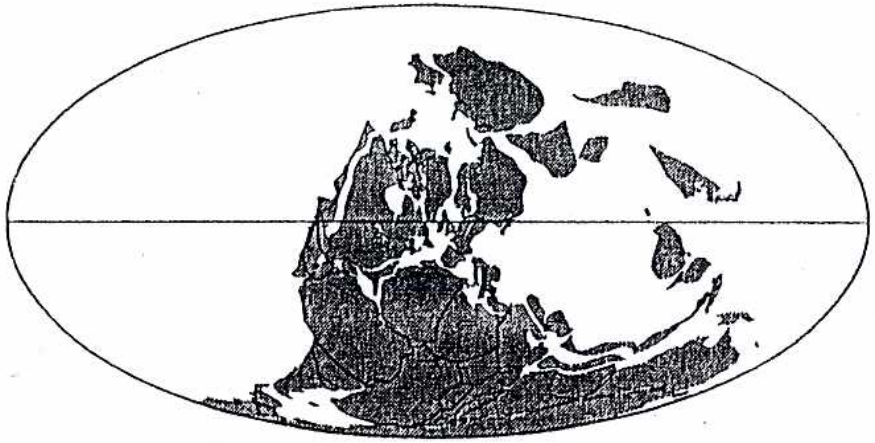
... 240 million years ago?

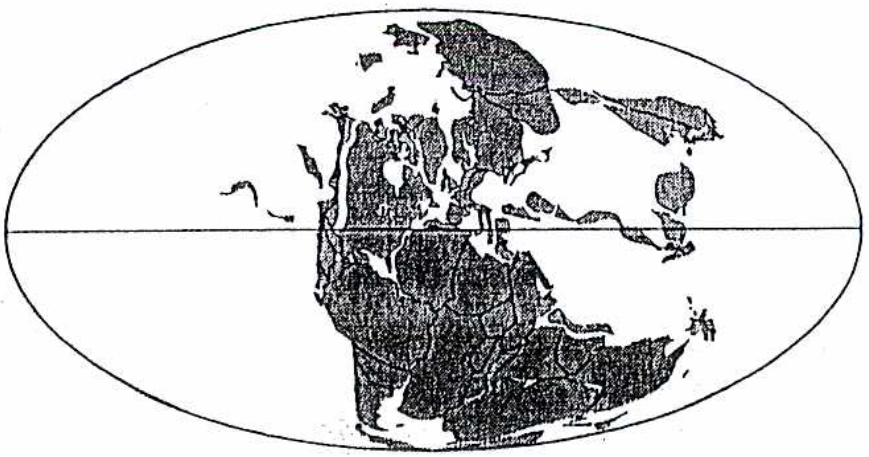
... 320 million years ago?

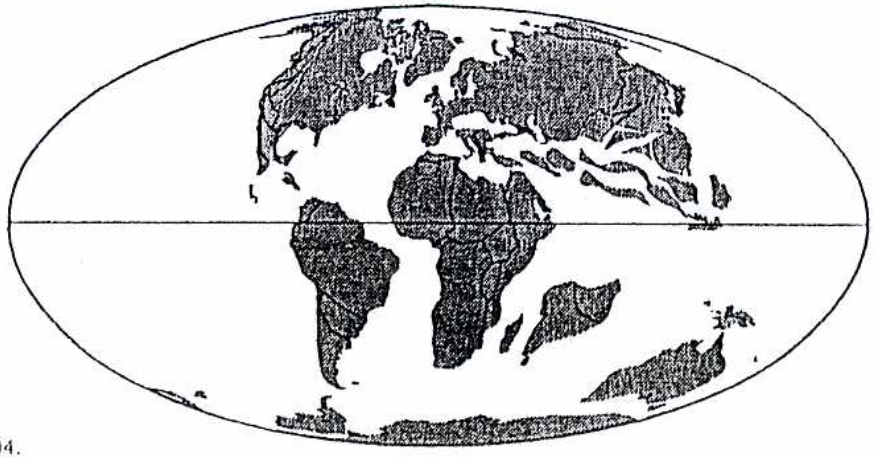
ALSO, mark an **X** over North America on each map.







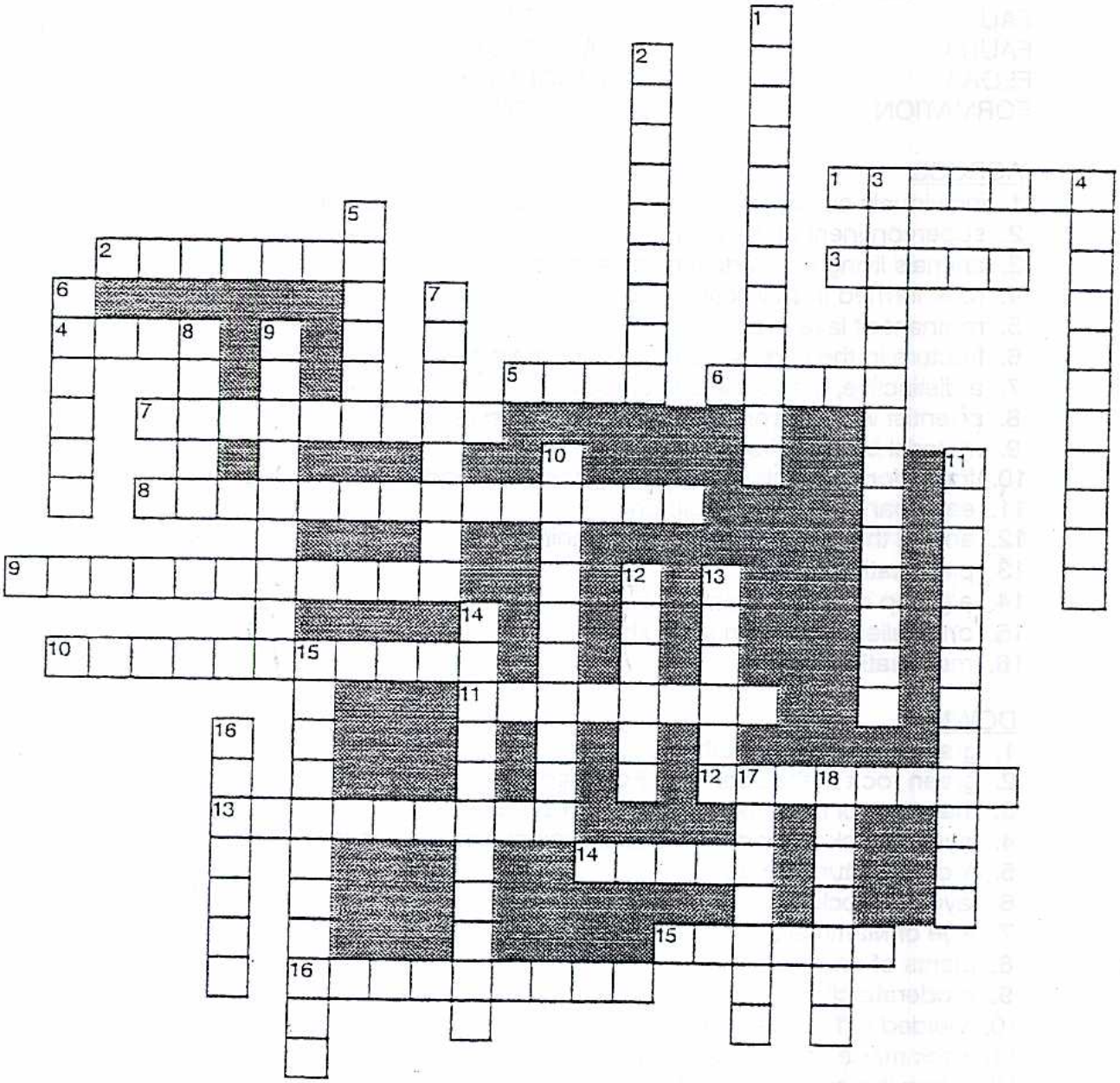




Maps images from the FLIPBOOK Continental Drift, by Christopher R. Scotese, University of Texas, 1994.

JOHN DAY FOSSIL BEDS NATIONAL MONUMENT

Crossword Puzzle – 7th Grade & up



CROSSWORD PUZZLE - 7TH GRADE AND UP

BASALT
CARNIVORE
CENOZOIC
CLARNO
CLAYSTONE
CONGLOMERATE
DIATOM
DIKE
FANGLOMERATE
FAULT
FAUNA
FLORA
FORMATION
GENUS
HERBIVORE
IGNEOUS
IGNIMBRITE
JOHN DAY
MASCALL
METAMORPHIC
OMNIVORE
PALEONTOLOGIST
PANGAEA
PLATE TECTONICS
PYROCLASTIC
RATTLESNAKE
SEDIMENTARY
SPECIES
STRATA
SUBTROPICAL
TEMPERATE
TERTIARY
TUFF
UPLIFT

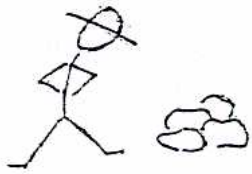
ACROSS

1. individuals so similar they can be called by the same name
2. supercontinent of the past
3. animals living in a certain place and time
4. rock formed from volcanic ash
5. remnant of lava in a fissure
6. fracture in the earth's surface where there has been movement
7. a distinctive, mappable unit of rock
8. scientist who interprets the past using fossils
9. material blasted from a volcano
10. formation in which Pliohippus bones are found
11. early part of the Cenozoic Era
12. animal that eats both plants and animals
13. plant-eating animal
14. a group of closely related species
15. one celled algae with silica shell
16. meat-eating animal

DOWN

1. gravel cemented together
2. green rock of the John Day Formation
3. the study of movement of the earth's plates
4. layered rock formed from bits and pieces of other rock
5. rock in Picture Gorge
6. layers of rock
7. Age of Mammals
8. plants of an area and time
9. moderate climate
10. welded tuff from a pyroclastic flow
11. rock made of cemented together deposits of alluvial fans
12. when the earth's surface is elevated
13. formation famous for the nut beds
14. rock that has been changed by heat and pressure
15. climate during Clarno "times"
16. colorful formation of tuffaceous claystone
17. formation formed from volcanic ash deposits 12 to 15 million years ago
18. rock formed from hot, molten magma

COOKIE TECTONICS



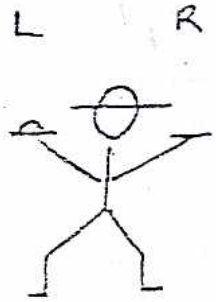
The rocks of eastern Oregon tell the dramatic story of plate tectonics.
Many of the rocks that make up the Blue Mountains were formed in the ocean. These rocks show the formation, migration, and subduction of the pacific plate at the western edge of North America.
As the pacific plate subducted beneath the North American plate, the material from the ocean floor was piled up against the edge of the continent into a mixture of rocks.

Three ancient rocks found in the eastern Oregon landscape:

1. **Basalt**, an igneous rock, formed in pillow shapes when formed in the ocean. Is often altered (metamorphosed) by heat, pressure and seawater into greenstones. (basalt may also form on land and cool into columns).

2. **Greenstone**, a metamorphic rock made up of seafloor minerals that are often polished smooth by faulting. **Serpentine** is considered a **greenstone**.

3. **Limestone**, a sedimentary deposit consisting largely of calcite. It may also include fragments of shells composed of calcium carbonate. Do you think shells might be found on the ocean floor?



This activity works best with sandwich cookies warmed to room temperature. Low-fat varieties don't work as well!!

How did these rocks get up into the mountains of eastern Oregon?

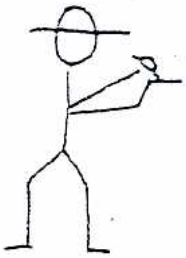
Take a sandwich cookie. No munching yet! Carefully separate the 2 halves of the cookie, so they don't break.

Hold the cookie with the most frosting in your left hand. Hold the cookie with the least amount of frosting in your **right** hand. Keep your hands about shoulder-width apart. The cookie in your left hand represents the pacific plate. The cookie in your right hand is the North American plate.

Now move your pacific cookie (left hand) slowly towards North America. The Pacific plate is moving slowly (about 5 cm per year) toward North America.

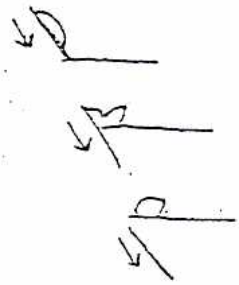
As the hot lava comes into contact with cold seawater, it quickly hardens to form a blob, or "pillow>" As more lava erupts under the blob, another blob forms. The lava inside the blob will cool more slowly than the outer "shell" of the blob. The blobs are shaped like 3 -foot long jelly beans.

The pacific plate cookie is mostly made up of **basalt** and **limestone**. Pillow basalt (which erupted out of underwater vents and volcanoes) and other rocks from deep beneath the surface of the earth were converted by the heat and pressure of metamorphism into **greenstone** and **serpentine**. The shells that contribute to the calcium carbonate of the **limestone** are the shells from animals like clams and oysters.



Eventually your pacific plate (oceanic) cookie comes into contact with the North American plate (continental) cookie. Since oceanic plate material is denser (heavier) than continental material, the oceanic cookie will be pulled under the continental cookie. This is called **subduction.**

As your pacific cookie is subducted beneath the North American cookie, scrape off the frosting on the pacific cookie into a big mound on the edge of your North American cookie. Careful! Too much force may fracture a tectonic plate!



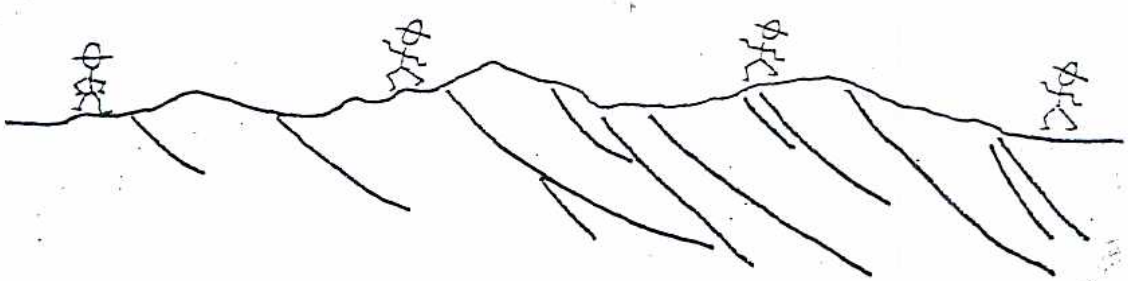
A frosting mound-building event.

During subduction, most oceanic plate rocks are crushed, melted and recycled back to the mantle under the earth's crust. Some rocks may be scraped off along the continent's edge forming a new coastline.

The mountains of eastern Oregon are the frosting!

The mound of frosting on your North American cookie represents the scraped off seafloor rocks of the pacific plate that were piled into the mountains of eastern Oregon.

Food for Thought:
The mountains of eastern Oregon were once the coastline, how many times do you think this land building process had to occur to make Oregon the size that it is today?

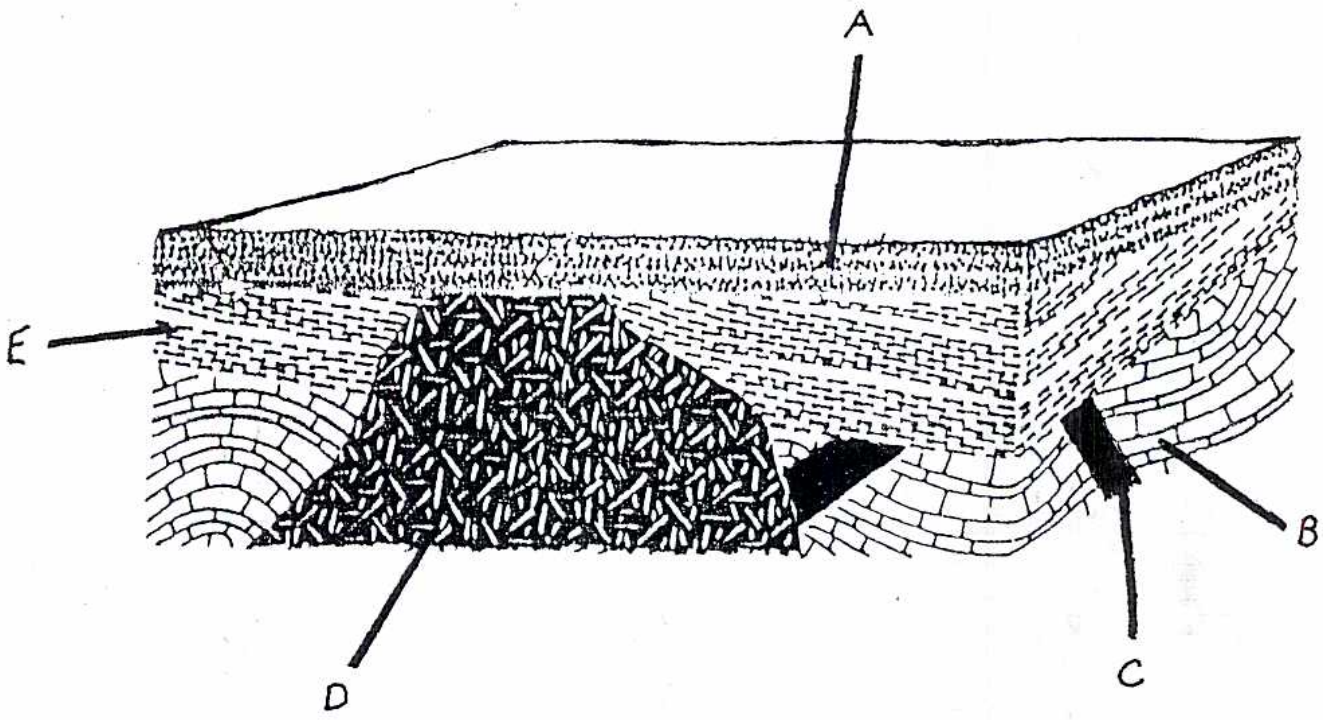


This exercise was adapted from a handout of the Marin Headlands in Sausalito, California.

GEOLOGIC PUZZLE ACTIVITY

1. Using the geologic law of "crosscutting relationships" unravel this block of earth. List the letters, representing strata, in order from youngest to oldest.

answer: _____



2. If you found a fossil in strata A, and one in strata B, which one would be older?

answer: _____

3. If strata A has been dated as 25 million years old, strata D as 27 million years old, and strata C as 30 million years old, how old would a fossil found in strata E be?

answer: _____

4. Which two strata are the least likely to contain fossils? (Why?)

answer: _____

JODA '99

The Clarno Unit Questions:

1. In the picnic area are three exhibits placed side by side. One of them is entitled "Giants and Pygmies." What are the titles for the other two?

2. Looking at the text on the same three exhibits, what is the four word definition given for the word "Paleontologists"?

3. What are the 200 foot cliffs, known as palisades, made of?

4. What kind of ecosystem (forest, desert, grassland, tropical forest, marsh) was there here 54 to 37 million years ago?

5. What were some of the mammals found here during this time?

6. What are the characteristics of a mammal?

While I was at the Clarno Unit.....

Draw a picture or write it down!

I saw:

I heard:

I smelled:

I felt:

I wondered-.

Then,- take your answers and make a poem or a story about your trip.

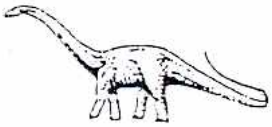
MAPPING FOSSIL PARKS

The National Park Service manages eight major fossil sites in the United States. Each is a window through which you can imagine the past life, as well as, enjoy the present. This activity will allow you to locate the eight fossil sites and contact each site for further information.

You will need to make use of western United States map that indicates cities and towns. On the attached map, draw a line from the park's drawing (see below) to the point within the state it is located (ex. see John Day Fossil Beds on the map). Take this on the road with you as a travel activity. You may wish to address a letter to the Superintendent of each park asking that they send you a park brochure container further information.

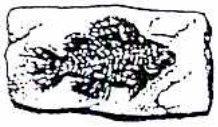
AGATE FOSSIL BEDS NATIONAL MONUMENT
P.O. Box 427, Gering, Nebraska 69341
(20 million year old animal fossils)

BADLANDS NATIONAL PARK
P.O. Box 6, Interior, South Dakota 57750
(37 to 23 million year old plant and animal fossils)



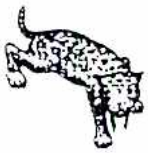
DINOSAUR NATIONAL MONUMENT
P.O. Box 210, Dinosaur, Colorado 81610
(145 million year old animal fossils)

FLORISSANT FOSSIL BEDS NATIONAL MONUMENT
P.O. Box 185, Florissant, Colorado 80816
(38 to 26 million year old plant and animal fossils)

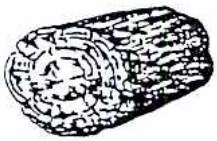


FOSSIL BUTTE NATIONAL MONUMENT
P.O. Box 592, Kemmerer, Wyoming 83101
(50 million year old animal fossils)

HAGERMAN FOSSIL BEDS NATIONAL MONUMENT
P.O. Box 570, Hagerman, Idaho 83332
(3 million year old animal fossils)



JOHN DAY FOSSIL BEDS NATIONAL MONUMENT
HCR 82, Box 126, Kimberly, Oregon 97848
(54 to 6 million year old plant and animal fossils)



PETRIFIED FOREST NATIONAL PARK
P.O. Box 2217, Petrified Forest National Park, Arizona 86028
(225 million year old plant and animal fossils)

Produced with Visitor Donations

Glossary

Anticline: An upward "n" fold in strata.
Andesite: Volcanic Rock containing mostly plagioclase (composition NaAlSiO to CaAlSiO)
Authigenic: Generated on the spot. Term applied to growth in place of occurrence.
Breccia: Sedimentary Rock of sharp angular fragments.
Conglomerate: A sedimentary rock with pebbles cemented together by finer material.
Cretaceous: Time period from about 140 to 65 million years ago, end of the Age of Dinosaurs.
Dike: Tabular body of igneous rock that cuts across the layers of adjacent rock, or cuts massive rocks.
Formation: Formations possess certain distinctive or combination of distinctive lithic (rock fragments, not feldspar grains, are determining factor) features. Boundaries are not based on time criteria.
Fusilinids: A fossilized single-celled marine animal.
Group: A combination of formations (q.v.)
Ignimbrite: Rock unit which developed from a pyroclastic cloud of super-heated volcanic material (much like a fiery tidal wave) which, after settling, welded together by its own heat.
K\Ar: Radiometric, potassium-to-argon gas, decay isotope age determination.
Laterite: Soil profile leached of its aluminum, silica, and soluble materials but retaining oxides and hydroxides of iron.
Liesegang: Rings or bands resulting from rhythmic precipitation in a gel.
Member: Subdivision of a formation (q.v.)
Metamorphic: Deformation in solid rock; by heat, pressure, or pronounced chemical action.
Rhyolitic: Volcanic rock containing mostly feldspar (composition Mal(AlSi)O were M can be K, Na, Ca, Ba, Rb, Sr, and Fe; makes up about 60% of the earth's crust) and quartz (a mineral of SiO)
Syncline: A downward "u" shaped fold in the strata.
Type Area: Stratagraphic section recognized as the standard, generally the one from which a stratigraphic unit received its name.
Unconformity: Pertaining to an erosional contact where strata join discontinuously. Generally an obvious line between strata is visible, indicating the point of missing strata due to erosion.
Vesicle: Small cavity in a mineral or rock.
Zeolites: A group of hydrous aluminosilicate minerals, noted for their ease of ion exchange.

Top-to-Bottom Formations and Members

recent erosional depositions
RATTLESNAKE FORMATION (8-6 mya)
MASCALL FORMATION (15-12 mya)
PICTURE GORGE BASALTS SUBGROUP (16 mya)
[part of Columbia Plateau Flood Basalt Group]
JOHN DAY FORMATION (39-20 mya)
Haystack Valley Member of JDF
Kimberly Member
Turtle Cove Member
Big Basin Member
CLARNO FORMATION (54-37 mya)
GABLE CREEK FORMATION, GOOSE ROCK CONGLOMERATES [near-shore ocean bottom deposits], and HUDSPETH FORMATION (all Cretaceous, approx. 100 mya)

Selected Bibliography

Italicized Citations indicate excellent teaching resource

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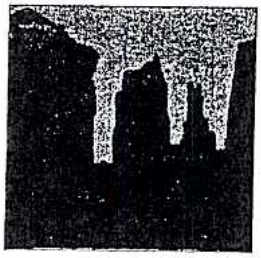
DISCOVERING YOUR NATIONAL PARKS

Use Web resources to plan real and virtual trips

I always valued taking part in outdoor education, conservation and camping programs with school groups. But no outdoor experiences compared to those special educational opportunities in summers and school vacations that involved traveling to national parks, including Acadia National Park in Maine, Algonquin Provincial Park in Canada, Rocky Mountain National Park in Colorado, and the Sequoia National Forest in California. Each one truly defined grandeur in unique ways, offering unparalleled aesthetic natural environments. I continue to be amazed by the foresight of legislators who long ago set aside those tracts for future generations. And from an educational perspective, most of the parks have museums and learning centers, distribute materials such as overview brochures and study guides, and offer on-site K-12 programs. But now, with growing interest in national parks and controversial new proposals to pave roads, build snowmobile trails, harvest timber and drill for oil, issues relating to protecting their legacy have never been more important.

Protecting the legacy of the national parks has never been more important.



REAL AND VIRTUAL VISITS Fortunately, the Web now makes pertinent resources on national parks easily accessible for everyone, so families or staff members who will make such visits this summer can use the materials to plan their trips. And, since even people who have not seen any or more than a few national parks are still expected to be informed voters, it is worthwhile to recommend Web sites in end-the-year school bulletins or newsletters. They also get students involved in meaningful research on conservation topics such as Save the Owls.

The sites that follow offer directories of detailed multimedia information from a variety of perspectives on each national park, including overviews, historical documents, program descriptions, background articles, maps, photos, film clips, 360-degree panoramic views, virtual reality activities and alerts about proposals, special interest groups and pending legislation. The resources will in turn direct you to Web sites targeted to specific parks, such as The Total Yellowstone Page, www.yellowstone-natl-park.com. It is time for educators, students and parents to tour their national parks, in person and online. **D**

NATIONAL PARK RESOURCES ON THE WEB

- **About U.S./Canadian Parks,** *usparks.about.com*
  An information directory offering guides to national and state parks, with background articles, photo collections, travel resources and featured destinations.
- **The American Southwest,** *www.americansouthwest.net*
  A multimedia site focusing on the parks and natural landscapes of southwestern United States.
- **Area Parks Network,** *www.areaparks.com*
  Selected park overviews, with travel information on transportation, dining, lodging and local activities.
- **Excursia National Park Guide,** *nationalpark.excursia.com/nationalpark*
  Overviews of selected parks with information on travel, local accommodations and related resources, from a publisher of travel magazines.
- **Mapping the National Parks,** *lcweb2.loc.gov/ammem/gmdhtml/nphtml*
  A Library of Congress collection of maps documenting the history, cultural aspects and geological formations of areas that became national parks.
- **National Parks Conservation Association,** *www.npca.org*
  A site dedicated to protecting national parks, with chat rooms, action alerts and features on topics such as cultural diversity and endangered species.
- **NationalParks.org,** *nationalparks.org*
  Resources from the National Park Foundation, with travel tips, message boards, opportunities to create online postcards and purchase park passes online.
- **ParkNet,** *www.nps.gov*
  A comprehensive National Park Service guide to parks, trails and historic sites in every state, with teacher materials, information on educational programs, and related resources.
- **Parks Canada,** *parkscanada.pch.gc.ca*
  An official guide to the national parks, historic sites and conservation areas of Canada, that presents information in English and French.
- **U.S. National Parks Net,** *www.us-national-parks.net*
  Independent information on each U.S. National Park, with online assistance for planning trips and vacations.

Odvard Egil Dyrli, dyrli@uconn.edu, is senior editor and emeritus professor of education at the University of Connecticut.