USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

FS-1195 | May 2022

Illustrations and graphic design by Nancy Lamm

The Jurassic World

and Other Exciting Times in the Geological Past of Colorado, Grand Mesa, Uncompahgre, and Gunnison National Forests

SEE

Colorado covered by an ancient ocean!

Glaciers and a landscape where mammoths walked!

One of the biggest long-neck dinosaurs known in North America!

Colorado covered with sand in a vast desert!

Long extinct giant mammals afoot in Colorado!

LEARN

How to decipher rock layers!

About dinosaur excavations!

EXPLORE

The ages of the Earth!

Colorado's Geologic Past!

BUT WAIT, THAT'S NOT ALL!

Secret coded messages!

Coloring pages! Puzzles!

INTRODUCTION

Okay, so *Supersaurus* didn't fly through Jurassic skies wearing a cape, but you probably knew that. The rest of the information in this activity book is true and provides insight into the wonderful story of the geologic past of Colorado. The Earth is very, very old, around 4.5 billion years old. Lots of strange creatures swam, crawled, walked, and flew across this corner of Colorado before the present landscape came to be. Their story is told in the rocks and fossils they left behind. Information about the environment where they lived is told in the bedrock and stratigraphy (rock layers). As you color the pages and solve the puzzles, think about the remarkable geologic story of this place.

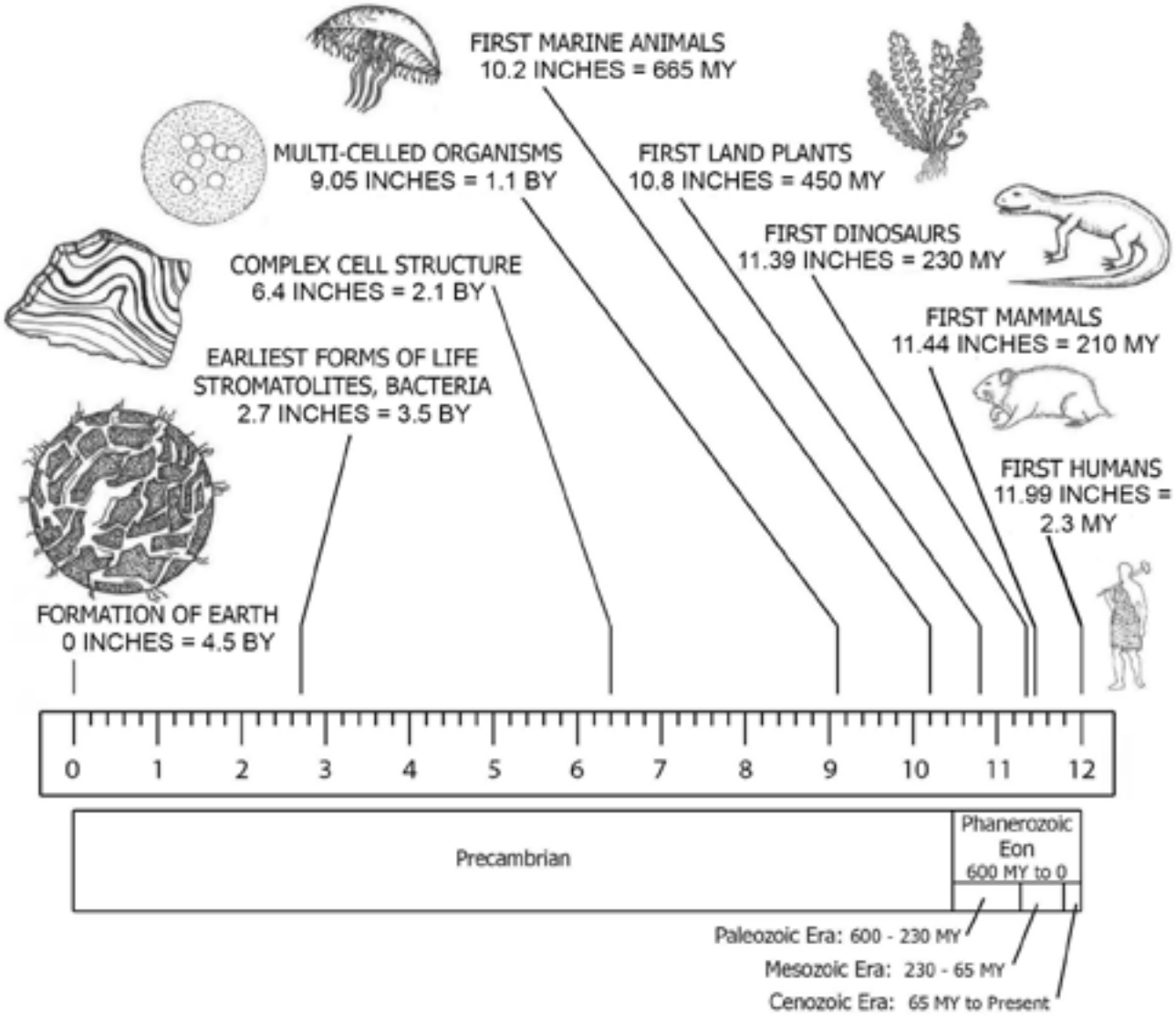
THE AGE OF THE EARTH AS A RULER

The ruler below represents the age of the Earth. Each inch on the ruler stands for 375 million years (375,000,000 years). Because the numbers are so large, scientists use abbreviations for a billiion years and a million years as follows:

BY = 1 billion years = 1,000,000,000 years

MY = 1 million years = 1,000,000 years

Major events in the history of the Earth are shown above the ruler. The names of geologic ages (eons and eras) are shown below the ruler.



THE PHANEROZOIC EON: TIME OF ABUNDANT LIFE ON EARTH

The Phanerozoic Eon is the last 1.6 inches on the 12-inch ruler on the previous page. We know more about this time than any other in Earth's history. Why? We know about it because scientists study the bedrock and piece together the Earth's history like a puzzle. Scientists who study rocks are called geologists. They know that limestone is deposited on an ocean floor, sand collects on a beach or desert, and coal is formed in swamps. From this kind of information, geologists have reconstructed the history of the Earth. The history of this part of Colorado is summarized below.

Geologists learn about the animal and plant life by studying the fossils (preserved remains of ancient life) present in the rock. These fossils can include impressions, bones, footprints, shells, replacement by rock (petrified wood), and even fossilized feces. The coloring pages that follow show what life and the landscape in Colorado might have looked like through the ages of the Earth.

ERA	PERIOD / EPOCH	SYMBOL	AGE	GEOLOGIC EVENTS IN COLORADO
CENOZOIC — AGE OF MAMMALS	QUATERNARY	Q		
	HOLOCENE		PRESENT TO 10,000	THE "RECENT" - HUMANS APPEAR IN NORTH AMERICA
	PLEISTOCENE		10,000 TO 2 M.Y.	THE ICE AGE, FOUR MAJOR ICE ADVANCES
	TERTIARY	T		ROCKY MOUTAINS BEGIN TO ERODE, VAST GRAVEL DEPOSITS
	PLIOCENE		2 M.Y. TO 6 M.Y.	5000 FEET ELEVATION OF ROCKY MOUNTAINS WITH PEAKS HIGHER THAN TODAY
	MIOCENE		6 M.Y. TO 22.5 M.Y.	
	OLIGOCENE		22.5 M.Y. TO 36 M.Y.	VOLCANOES IN SAN JUAN MOUNTAINS
	EOCENE		36 M.Y. TO 58 M.Y.	VAST LAKES AND LAKE-BOTTOM SHALE DEPOSITS IN WESTERN COLORADO AND IN UTAH
	PALEOCENE		58 M.Y. TO 65 M.Y.	LONG EPISODE OF MOUNTAIN BUILDING FORMED PRESENT DAY STRUCTURE OF THE ROCKY MOUNTAINS
MESOZOIC — AGE OF DINOSAURS	CRETACEOUS	K	65 M.Y. TO 141 M.Y.	THE SEAS CAME IN, THE SEAS WENT OUT MARINE, NEAR SHORE, AND LAGOON (COAL) DEPOSITS
	JURASSIC	J	141 M.Y. TO 195 M.Y.	RIVER SYSTEMS, MARSHES, SAND DUNES
	TRIASSIC	Tr	195 M.Y. TO 230 M.Y.	EROSION OF MOUNTAINS, DEVELOPING RIVER SYSTEMS
PALEOZOIC — TERRESTRIAL LIFE	PERMIAN	P	230 M.Y. TO 280 M.Y.	EROSION OF MOUNTAINS, VAST SAND DUNES
	PENNSYLVANIAN	IP	280 M.Y. TO 310 M.Y.	EROSION OF MOUNTAINS UPLIFT OF ANCESTRAL ROCKY MOUNTAINS
	MISSISSIPPIAN	M	310 M.Y. TO 345 M.Y.	
PALEOZOIC — FISH	DEVONIAN	D	345 M.Y. TO 395 M.Y.	OCEAN DEPOSITS
	SILURIAN	S	395 M.Y. TO 435 M.Y.	OCEAN DEPOSITS AND EROSION
PALEOZOIC — LIFE EXPLODES IN THE SEAS	ORDOVICIAN	O	435 M.Y. TO 500 M.Y.	
	CAMBRIAN	€	500 M.Y. TO 600 M.Y.	OCEAN DEPOSITS
PRECAMBRIAN		p€		GRANITE "BASEMENT" ROCK

* Chart showing geologic ages and events in Colorado based on research by many geologists.

THE PRESENT IS THE KEY TO THE PAST

This is one of the first lessons learned by geologists. "The present is the key to the past" means that geologic events we observe today likely took place in the past and shaped our world in similar ways as today. Volcanoes, floods, ocean tides, winds, gravity, as well as sedimentation and erosion have likely behaved in a similar manner throughout time. Earth is a very dynamic place, although we don't always notice it except for major disasters like earthquakes, landslides, and floods. A human lifespan is just a tiny moment in the age of the Earth. Geologists work to understand geologic time and all the events that have occurred over millions of years.

The driving force of all this change is plate tectonics (the movement of large plates of the Earth's crust). Colliding plates can create mountain ranges and reshape the Earth's continents. As the plates slowly shift across the globe, volcanoes and earthquakes represent the immense power at play. Glacial ice advances then melts; wind and water erode mountains until they are flat; valleys fill with rock and debris washed down from highlands. Change is constant throughout the history of the Earth.

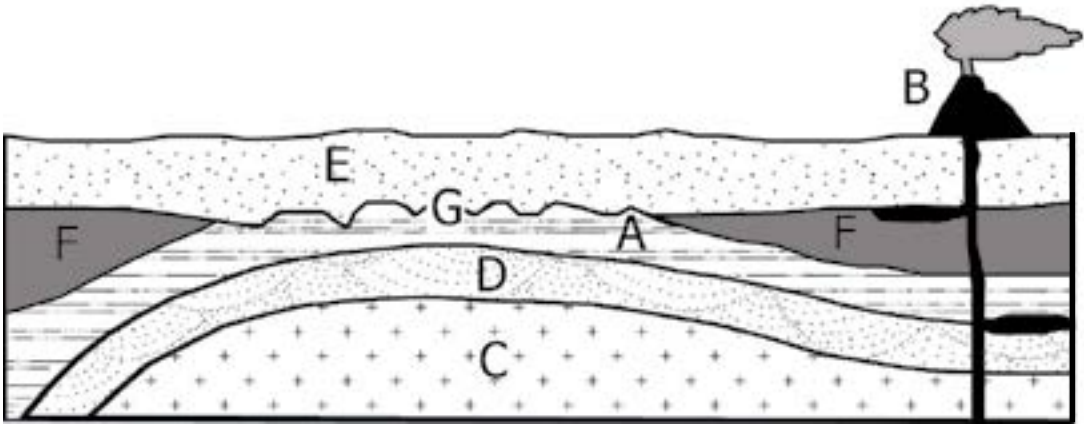
Fossils preserved in rock provide clues to the environment and what kinds of plant and animal life existed during the Earth's changes. Tropical fern plants suggest a warm, moist environment. Shark teeth, shells, and fish fossils indicate that oceans once covered areas that are now dry. Colorado has been at the bottom of an ocean several times, has been covered by ice, and has seen the rise and erosion of vast mountain ranges long before the Rocky Mountains of today were formed. This story is told in the rocks and fossils around us.

GEOLOGY PUZZLE

Put on your detective hat and figure out the storyline! What happened first and last in the drawing below?

Geologists know that the oldest sedimentary rocks are at the bottom and younger layers of sedimentary rocks are above them. The sediments, such as grains of sand and particles of clay, are laid down in a generally horizontal position. The sediments are then squeezed down by more sediment laid down on top of them and, over time, they turn into sedimentary rock.

These horizontal rock layers can be changed over time by events occurring inside or on the surface of the Earth. Examples of such changes include volcanic activity in which molten rock cuts through older rock, cracks (geologists call them faults) which break through rock layers, and folding or tilting of rock layers. In addition, surface processes such as landslides and erosion by water or wind wear down mountains, and the sediment is carried and deposited downstream and far away, into the oceans. Look at the diagram below and see if you can figure out the order in which rocks were formed and when events changed them.



Youngest _____

_____

_____

_____

_____

_____

Oldest _____

ANSWERS ARE ON THE BACK OF THE BOOK.

MISSISSIPPIAN PERIOD: 310 TO 345 MILLION YEARS AGO

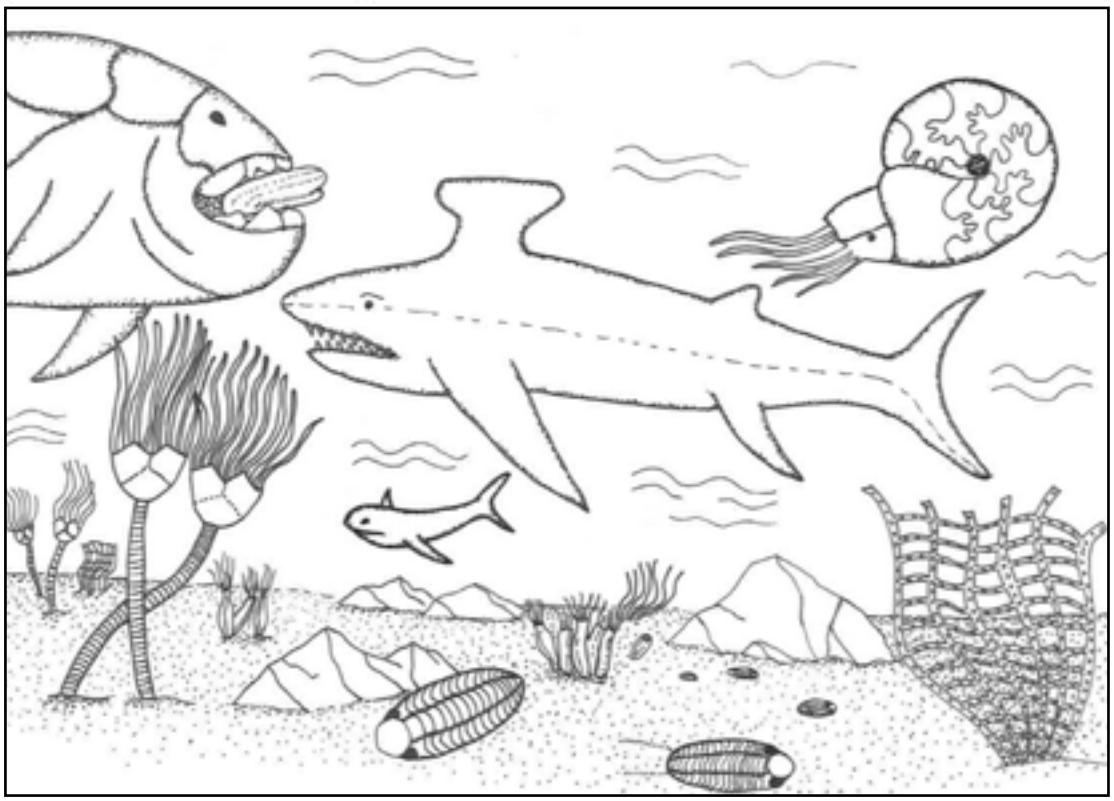
An ocean that teemed with life covered southwest Colorado during the Mississippian Period. Early sharks with a strange-looking dorsal fin swam along with large, coiled-shell ammonites, a relative of squids. Segmented creatures called trilobites crept along the ocean floor with many walking legs. Sea lilies (called crinoids) were animals attached to the ocean floor by long stems with tentacles at their tops to catch food. *Archimedes* bryozoans (similar to corals) grew in a tiny corkscrew spiral.

Fun Fossil Fact: Ammonites differed from snails because their shells contain chambers. The edges of the chambers can be exposed on the sides of the shells as "suture patterns." These patterns could be quite simple or very wavy and complex.

Trilobite

Crinoid

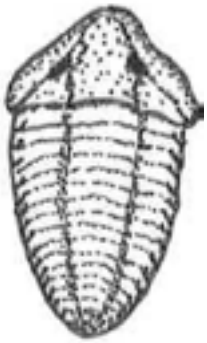
Archimedes
Bryozoan



PENNSYLVANIAN PERIOD: 280 TO 310 MILLION YEARS AGO

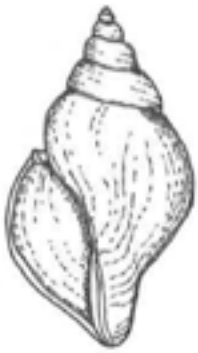
Three hundred million years ago, the oceans had retreated and southwest Colorado was the site of eroding mountains above closed-in basins surrounded by desert sand dunes. In Colorado, the sediments of the Paradox Valley were being deposited. Plants were growing on the land and animals had long ago emerged from the ocean, evolving as land dwellers. Giant insects flew through the Pennsylvanian air. In the oceans, life still teemed with fish, including sharks, trilobites, coral, and ammonites.

Fun Fossil Fact: The dragonfly shown could grow as large as 2½ feet across!



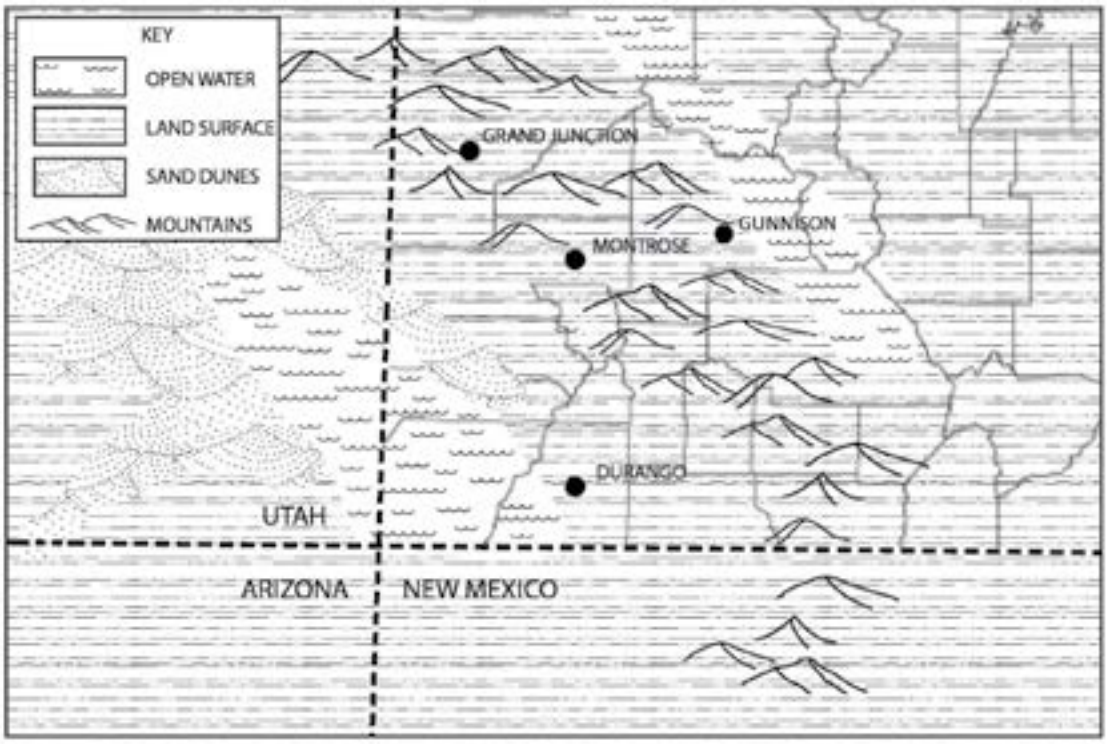
Trilobite

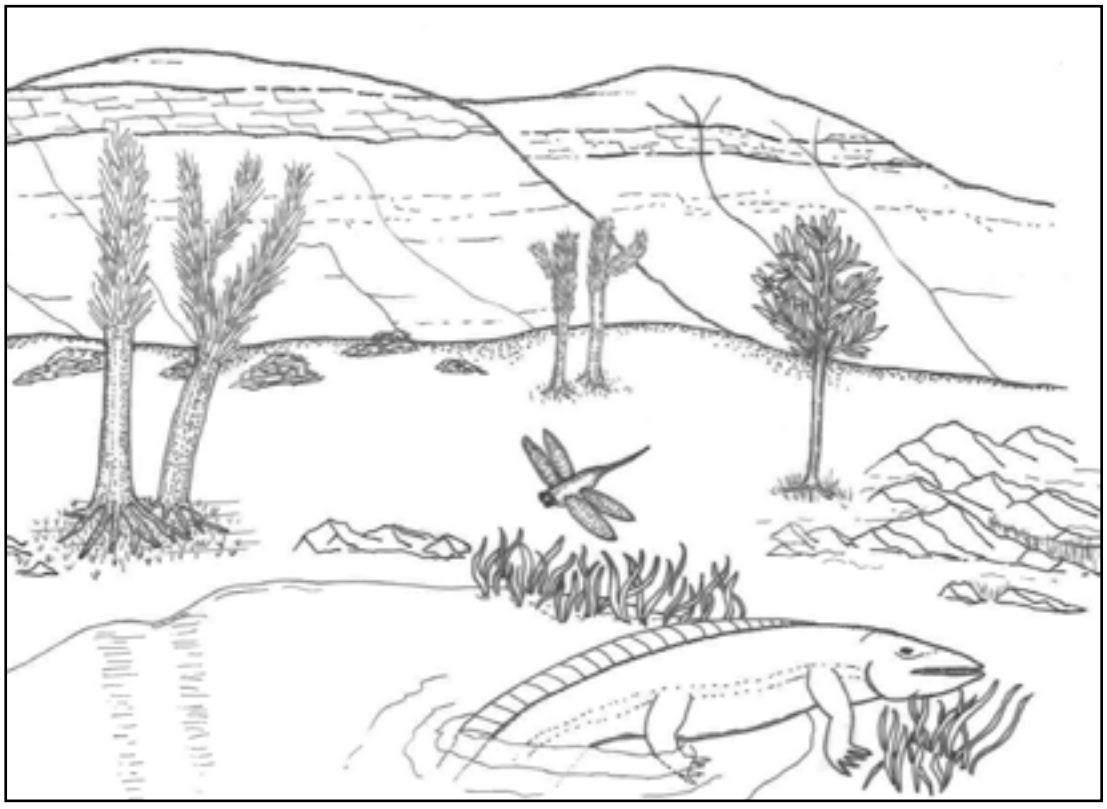
Brachiopod
(clam-like animal)



Gastropod
(snail)

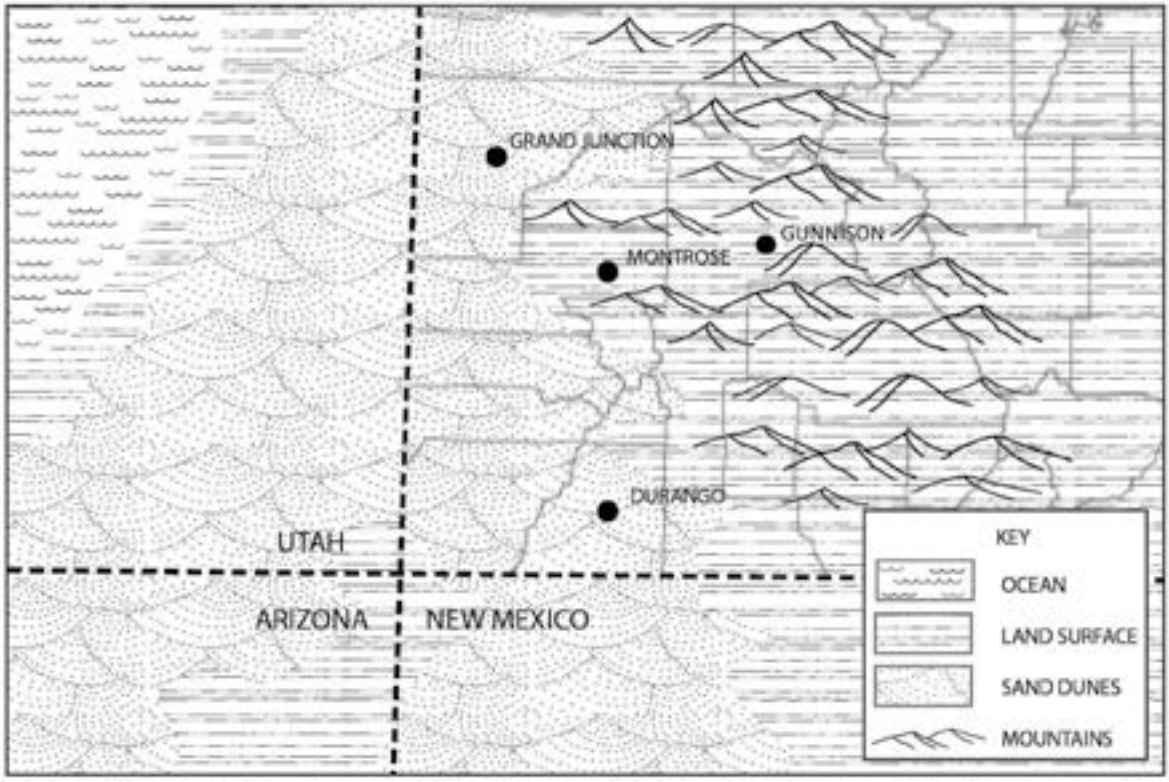
Horn coral

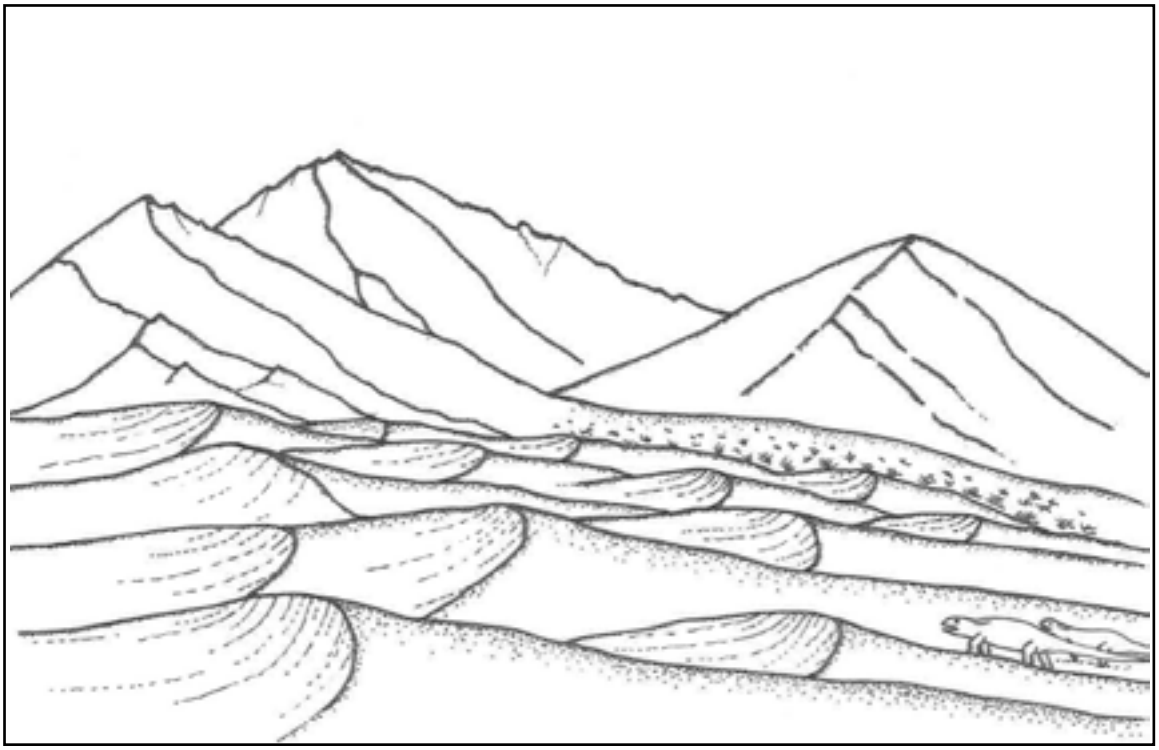




JURASSIC PERIOD: 141 TO 195 MILLION YEARS AGO

A vast desert of sand dunes covered western Colorado around 195 million years ago. The sandstone cliffs of Colorado National Monument are the solidified remains of these dunes. Some mammals lived during the Jurassic, but the land was ruled by many different kinds of dinosaurs. The very first birds made an appearance in the Jurassic, having evolved from small carnivorous dinosaurs. Ammonites, snails, clams, sea urchins, and starfish lived in the ocean along with fish. Trilobites, however, had become extinct by the end of the Paleozoic.





Dinosaur trackways: sauropods (round) and theropods (3-toed)

THE STORY OF DRY MESA DINOSAUR QUARRY

Eddie and Vivian Jones enjoyed spending time looking for dinosaur fossils on the mesas above their hometown of Delta, Colorado. One day in 1971, they discovered a very large claw bone sticking out of a hillside on Dry Mesa, on the Uncompahgre National Forest. The bone was found in pink- and green-colored mudstone of the Jurassic-age Morrison Formation. The Joneses knew that the rocks in the Morrison Formation were deposited as sediment during the time that dinosaurs roamed the Earth. They contacted Dr. Jim Jensen, a paleontologist (a scientist who studies ancient life) of Brigham Young University in Provo, Utah, and asked him to come and look at what they had found. "Dinosaur Jim" was very excited about the discovery and contacted the U.S. Department of Agriculture (USDA), Forest Service local office to ask for a permit to begin digging and searching for more fossils.

Dr. Jensen, along with other professors and students from the university, worked at Dry Mesa Quarry for nearly 30 years. They collected approximately 4,000 bones from 30 different creatures, including dinosaurs, pterosaurs, crocodiles, turtles, lungfish, and a shrew-like mammal. The bones were found jumbled together in a 2- to 6-foot-thick sedimentary rock layer. Paleontologists think that after the animals died, their bones were washed away by floods and deposited on the sides of a stream channel. More floods brought more sediment and more bones, which covered the older bones. Over millions of years, the sediment was compacted and became rock, and the bones became fossilized.

The Late Jurassic bone bed at the Dry Mesa Quarry represents a diverse group of dinosaurs based on the number of different bones. Fossils at Dry Mesa include theropods (meat-eating dinosaurs) such as *Torvosaurus, Ceratosaurus, Allosaurus, Marshosaurus, and Stokesosaurus;* ornithischians ("bird-hipped" dinosaurs) such as *Dryosaurus, Othnielia, Camptosaurus,* and *Stegosaurus;* and giant sauropod (long-necked plant eaters) dinosaurs such as *Apatosaurus, Barosaurus, Camarasaurus, Diplodocus, Supersaurus, and Ultrasauros* (today some scientists believe the *Ultrasouros* bones are *Brachiosaurus).*

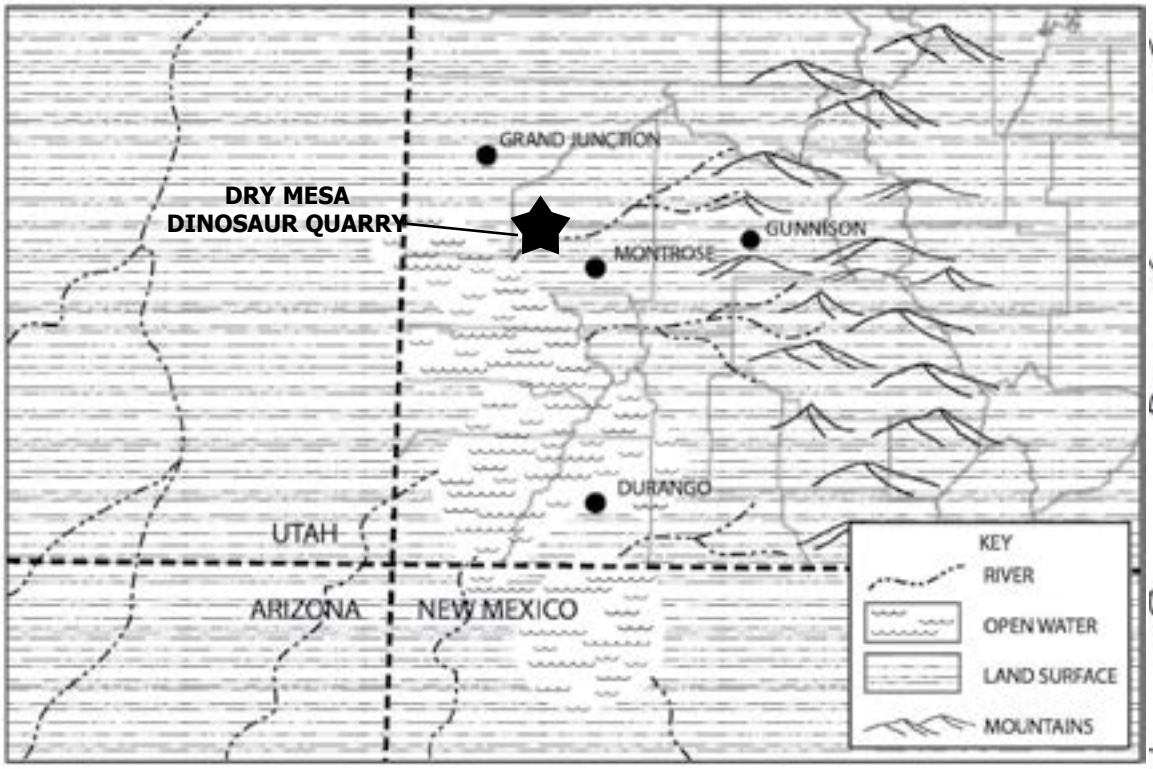
One of the most important finds is *Torvosaurus,* which was the *T. rex* of its day (but about 90 million years older than its distant cousin *Tyrannosaurus). Torvosaurus* was 35 feet long, weighed 3 tons and was overall more heavily built than other big meat-eaters of the late Jurassic like *Allosaurus. Torvosaurus* had short, powerful arms with three fingers bearing enormously long, sharp claws. Some scientists think the larger and more heavily built design of *Torvosaurus* suited it for hunting the largest sauropod dinosaurs.

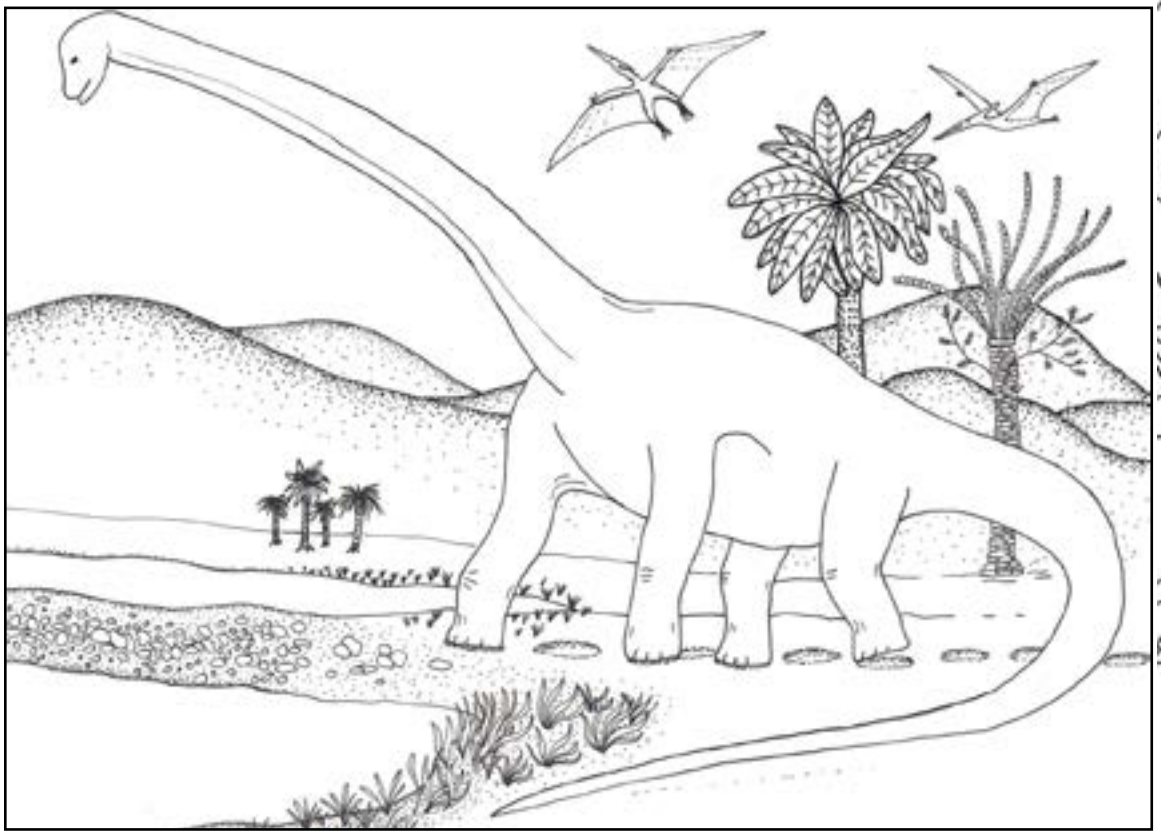
Dry Mesa Quarry is especially recognized for bones of large sauropod dinosaurs, including *Supersaurus and Ultrasauros* among the most famous finds. *Supersaurus* is among the largest of all sauropod dinosaurs to exist on the Earth. The *Supersaurus* shoulder blade bones are 8 feet long. One especially large neck bone of *Supersaurus* from the middle of the neck (see drawing at right) is 4 feet long. That means the complete *Supersaurus* neck is 56 feet long, which is longer than most schoolbuses! And the entire animal would be at least 164 feet long! Weighing as much as 80,000 pounds, about as much a 6 bull African elephants, it was definitely a supersized-saurus!

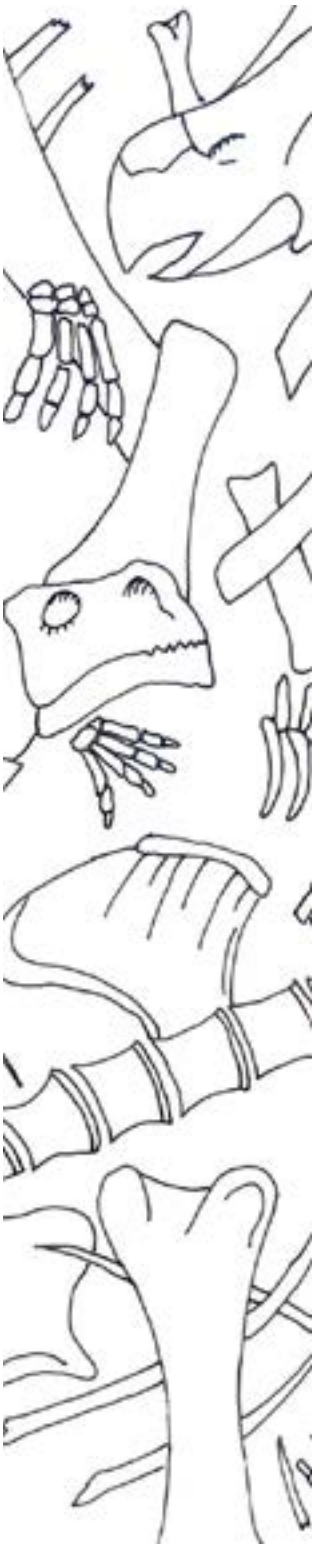
Another amazing shoulder blade from the quarry belongs to a different sauropod that "Dinosaur Jim" named *Ultrasauros*. Although scientists now think the shoulder blade may actually belong to *Brachiosaurus,* it is definitely another huge and different sauropod dinosaur from the Dry Mesa Quarry.

JURASSIC MORRISON FORMATION AND THE DRY MESA DINOSAUR QUARRY

The Dry Mesa Dinosaur Quarry is found within the Morrison Formation, Colorado's own "Jurassic Park." Dinosaur bones and footprints occur frequently in Morrison Formation rock layers that preserve an environment of stream channels meandering across a broad savannah and sediment layers deposited when streams flooded over their banks. Dinosaur remains have been found in the Morrison Formation in Colorado and west into Utah, including Dinosaur National Monument. The Morrison Formation is a colorful interbedded mix of red, green, and gray mudstone and light tan beds of sandstone.







Fossil quarry site

CRETACEOUS MANCOS SEAWAY: 80 TO 100 MILLION YEARS AGO

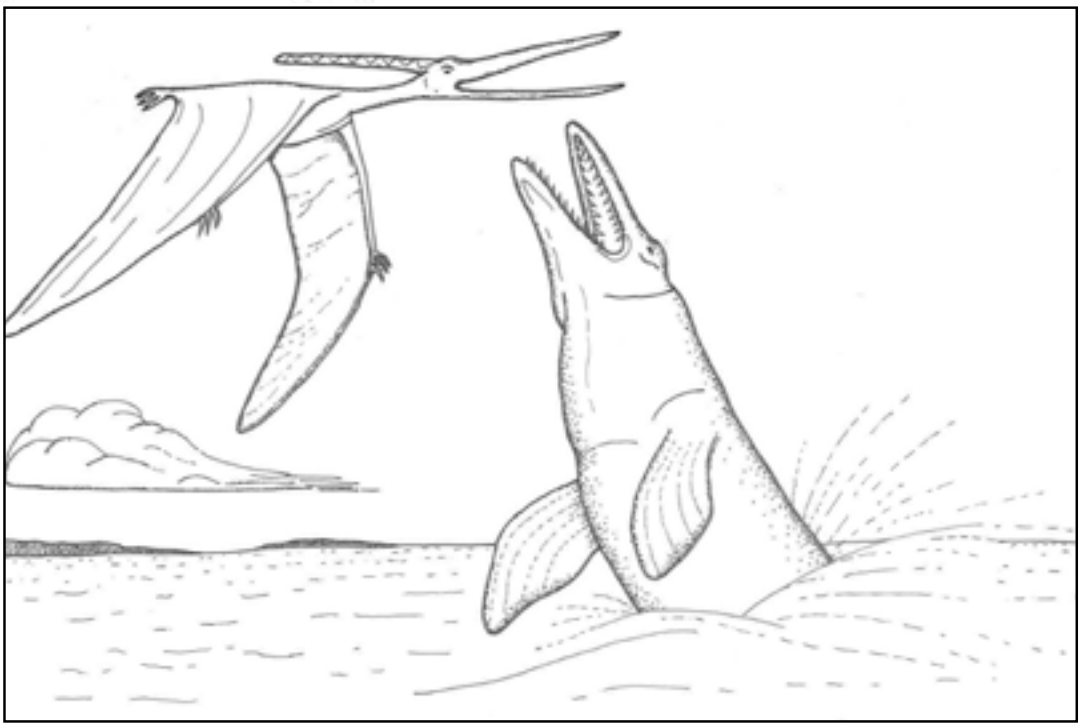
Around 100 million years ago, the broad, open savannahs of the Morrison Formation were covered by an advancing sea, with beaches and shorelines represented by the Dakota Sandstone. The Mancos Shale is known locally as the "adobe badlands," and is exposed widely on the land surface around the Uncompahgre Valley and in the vicinity of Cortez and Mancos, Colorado, for which it was named. The Cretaceous seas teemed with sea urchins, sharks, ammonites, and clams. The waters were also home to giant marine reptiles like the mosasaur, shown below lunging from the water at a giant flying reptile called a pterosaur. Sediments were deposited along shorelines and in swamps as the Mancos sea gradually retreated to the east. The swamp deposits were metamorphosed (caused by burial beneath sediment layers that were deposited later) into the coal deposits of the Mesaverde Formation.

Sea urchin

Shark tooth

Ammonite

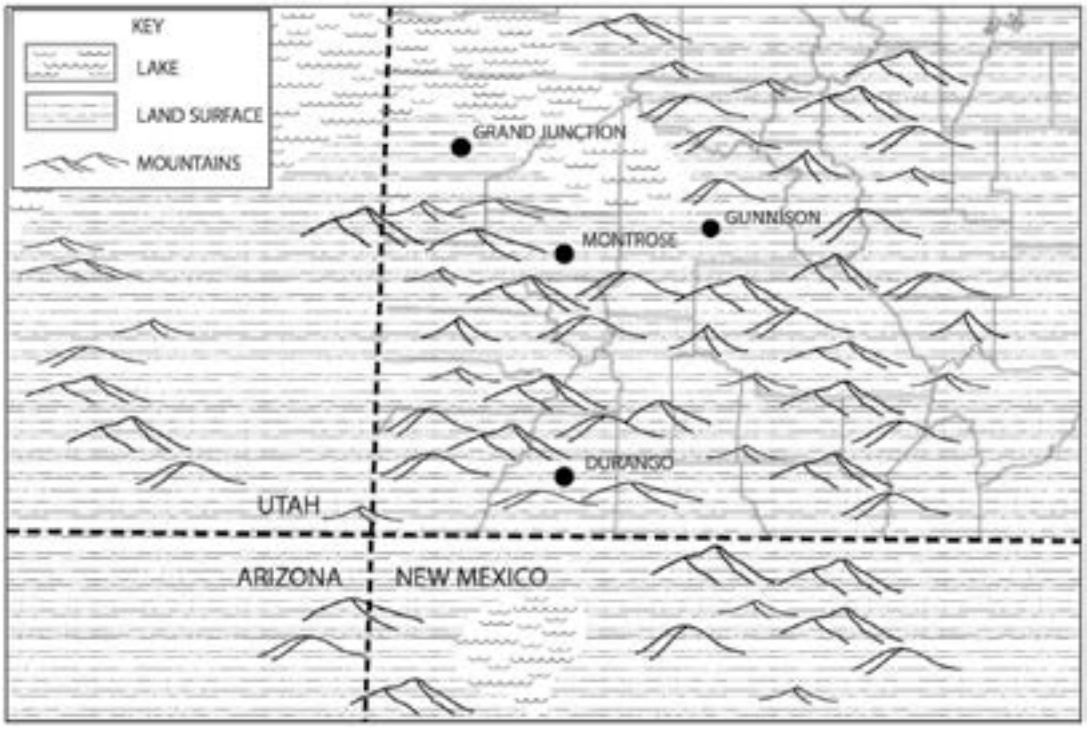
Bivalve (clam)



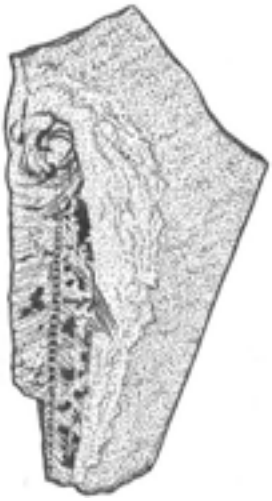
EOCENE EPOCH: 36 TO 58 MILLION YEARS AGO

A great period of mountain building, called the Laramide Orogeny, took place near the end of the Mesozoic (Age of Dinosaurs) and the start of the Cenozoic (Age of Mammals). By the time of the Eocene, these mountains had already eroded and some areas between the mountains were filled with great lakes. These vast lakes deposited rock layers called the Green River Formation across what is now western Colorado. The lake deposits of the Green River Formation are famous for their beautifully preserved fossils of whole fish as well as individual scales. Other fossils include plants, insects, and petrified wood.

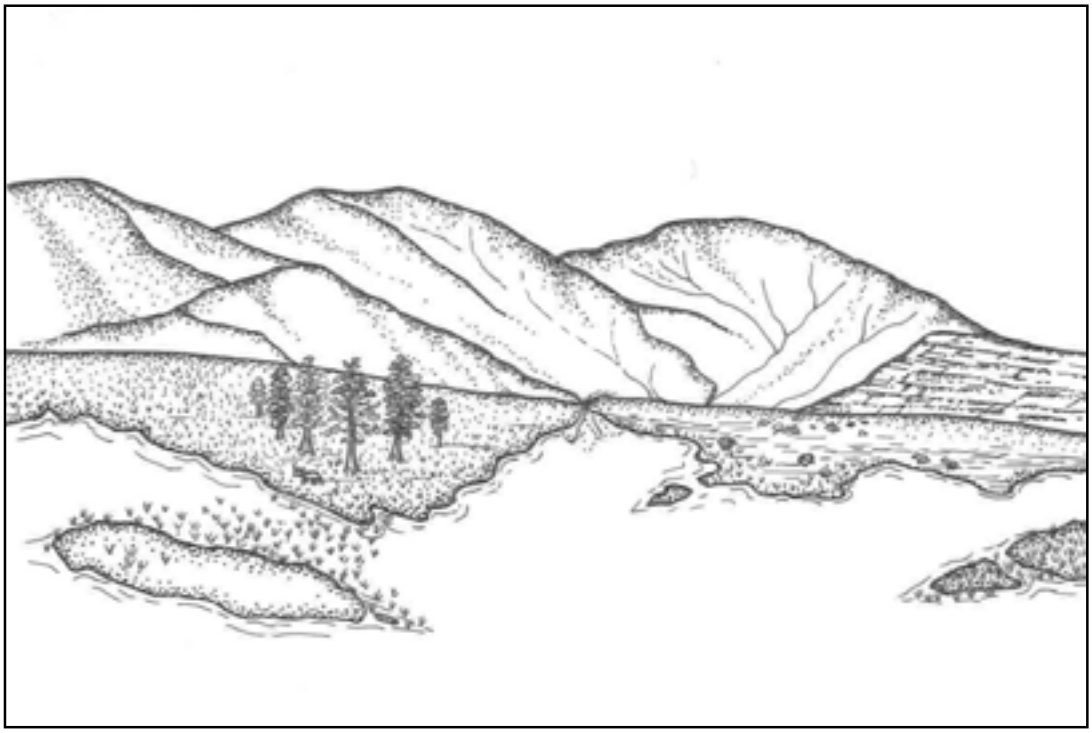
Fun Fossil Fact: The oldest known flying mammal fossil, a bat, was collected from the Green River Formation with food still intact inside its body.



Fern fossil



Fossil fish

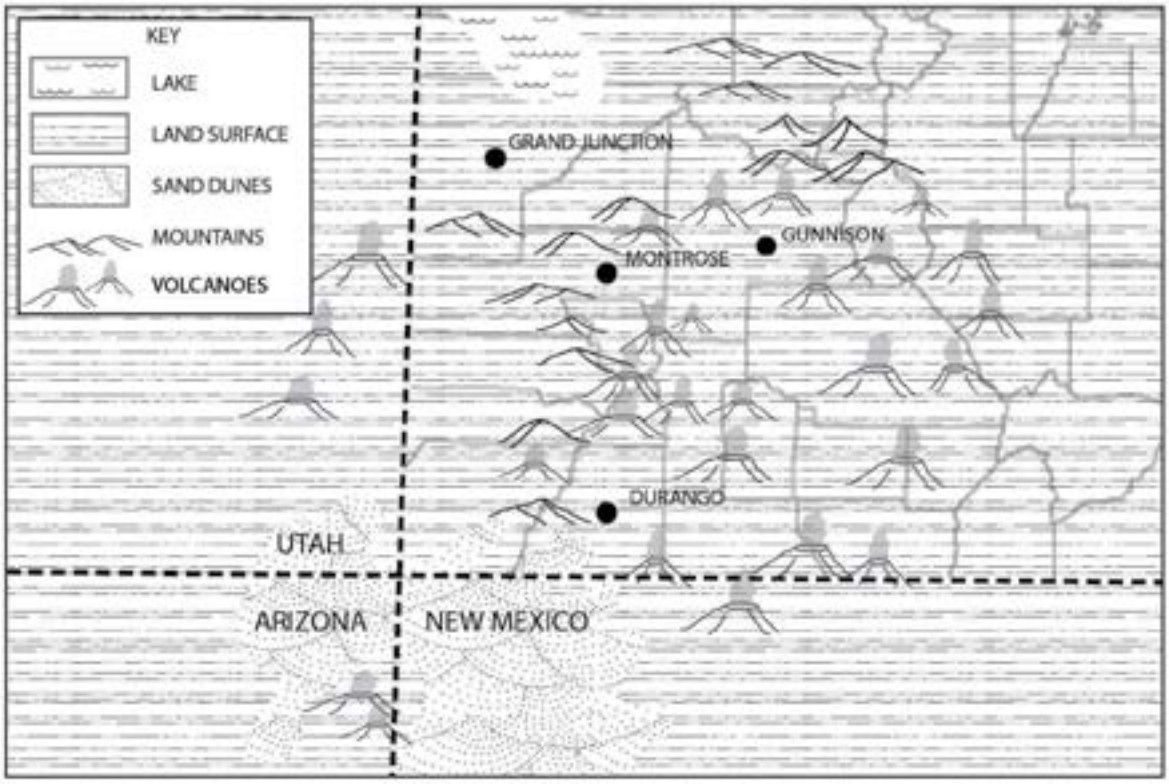


Petrified wood

OLIGOCENE EPOCH: 22.5 TO 36 MILLION YEARS AGO

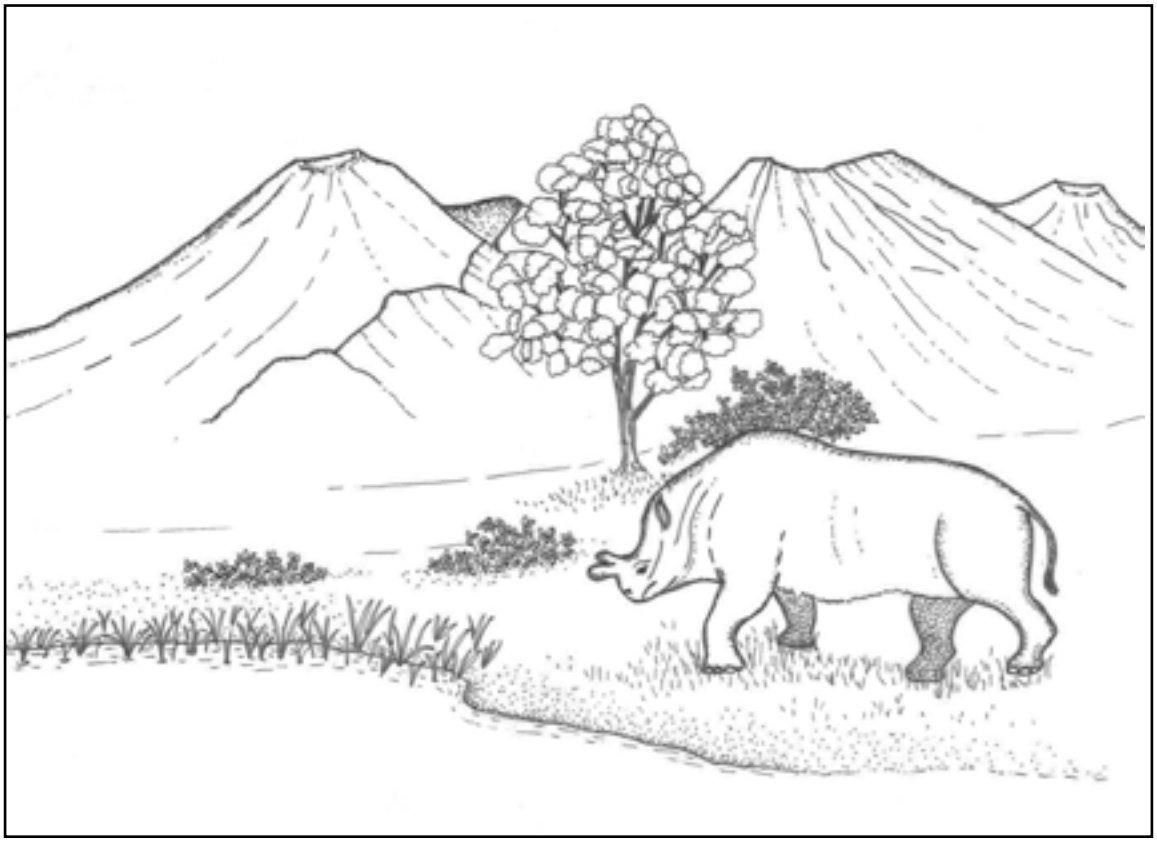
Volcanoes were scattered across southwestern Colorado during the Oligocene around 30 million years ago. Eruptions of these volcanoes were violent, blanketing the region with volcanic ash and rock debris. The volcanic rocks of the Oligocene are much older than the volcanic rock cap of Grand Mesa, which is about 10 million years old and flowed out across the ground surface from fissures in a less explosive manner. Great mammals including rhinoceros-like brontotheres, camels, and pig-like entelodonts walked the land.

Fossilized wood



Entelodont

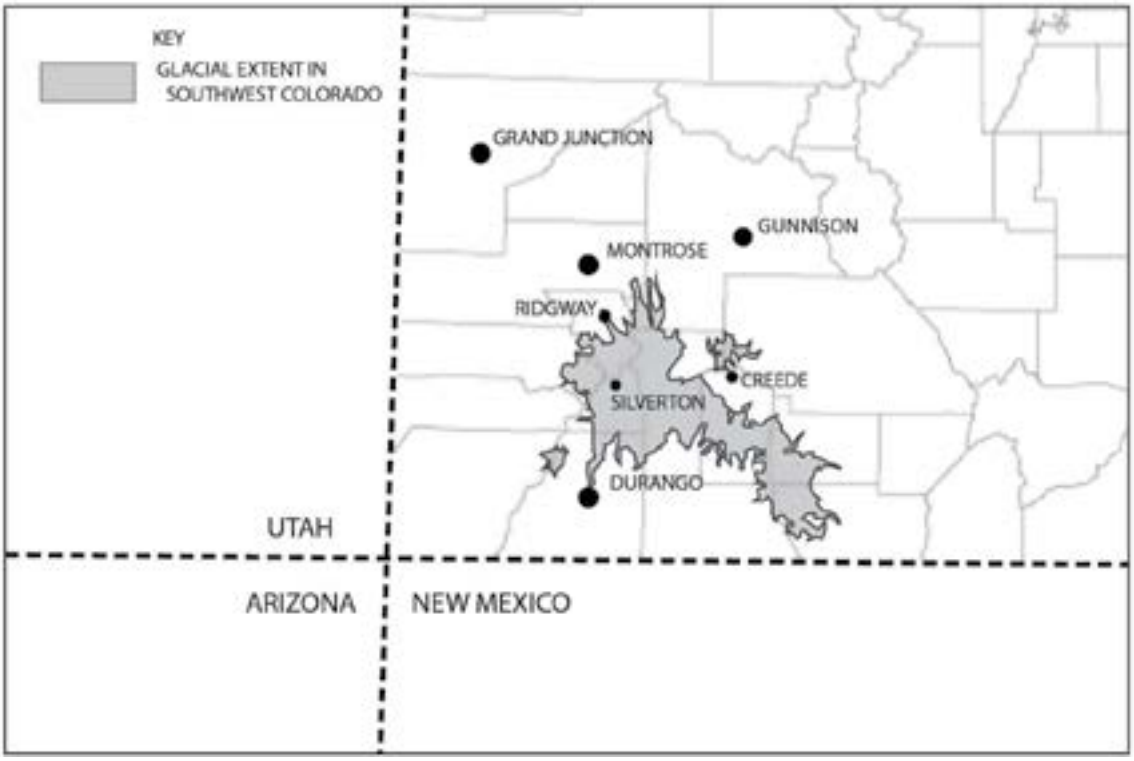
Bivalve (clam) shells



PLEISTOCENE EPOCH (THE ICE AGE): 10,000 YEARS TO 2 MILLION YEARS AGO

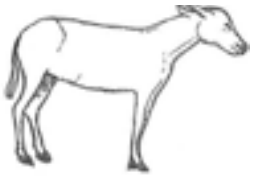
The Pleistocene is called the Ice Age for good reason. A vast ice sheet descended down from Canada across the North American Continent. Ice nearly completely covered the land, and only the highest mountain peaks were visible in the Rocky Mountains. The map shows the approximate extent of the ice in the San Juan Mountains. Ice didn't completely cover the mountains, but only the highest peaks would show. Animal life was vastly different from present-day wildlife and included elephant-like mammoths and mastodons, ground sloths, saber-toothed cats, and early horses.

Fun Fossil Fact: Horses became extinct on the North American Continent near the end of the Ice Age and were brought back to North America by European explorers 10,000 years later.

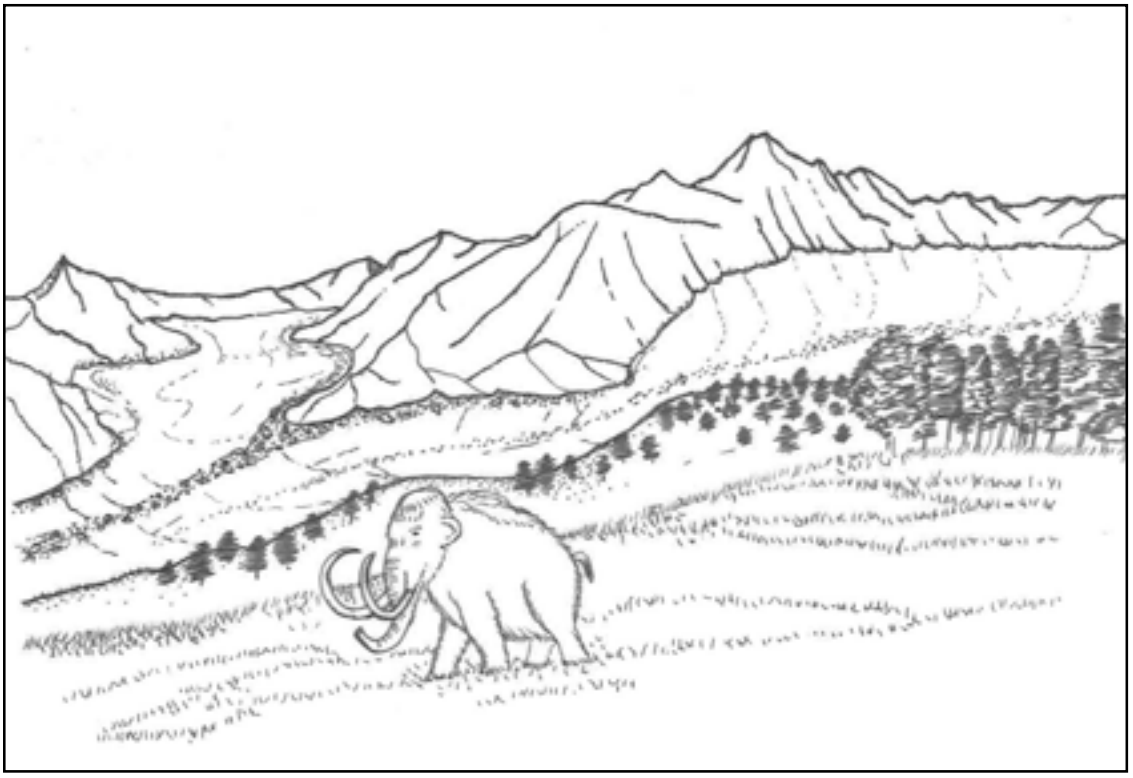


Dire wolf

Bison



Equus (wild horse)



Sabertooth cat

Mastodon

Short-faced bear

WORD SEARCH

Try to find the following words in the grid below. ANSWERS ARE ON THE BACK OF THE BOOK.

QUATERNARY	HOLOCENE	PLEISTOCENE	TERTIARY	PLIOCENE
MIOCENE	OLIGOCENE	EOCENE	PALEOCENE	CRETACEOUS
JURASSIC	TRIASSIC	PERMIAN	PENNSYLVANIAN	MISSISSIPPIAN
DEVONIAN	SILURIAN	ORDOVICIAN	CAMBRIAN	GEOLOGY
DINOSAUR	QUARRY	FOSSIL	SUPERSAURUS	ROCK
ALLOSAURUS	GLACIER	PALEONTOLOGY	DESERT	AGES
CENOZOIC	PALEOZOIC	MESOZOIC		

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

CODED MESSAGES

Try to decipher the messages below. Each letter in the alphabet represents another letter.
Write your answer below the code. A clue is given at the bottom of the page.
ANSWERS ARE ON THE BACK OF THE BOOK.

FRL BWLKLDF YK FRL OLZ FG FRL BMKF

_____

GDCZ VRMDQL YK VGDKFMDF

_____

SCRAMBLED WORDS

These fossil names are scrambled. Try to spell the fossil. As a hint, each fossil is shown in the pictures.
ANSWERS ARE ON THE BACK OF THE BOOK.

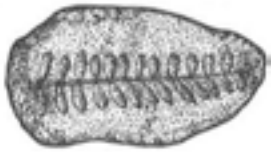
1. T T L B I O R E I _____

2. T O M M M A H _____

3. D O O S N A M T _____

4. D R O C O B A H I P _____

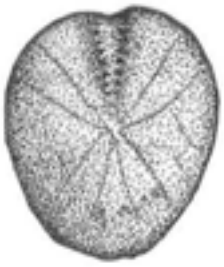
5. R O C N I I D _____



6. N O H R R L C O A _____

7. R M N O C E E D I H _____

8. A O E N M M I T _____



9. N R F E A E L F _____

10. H F S I _____

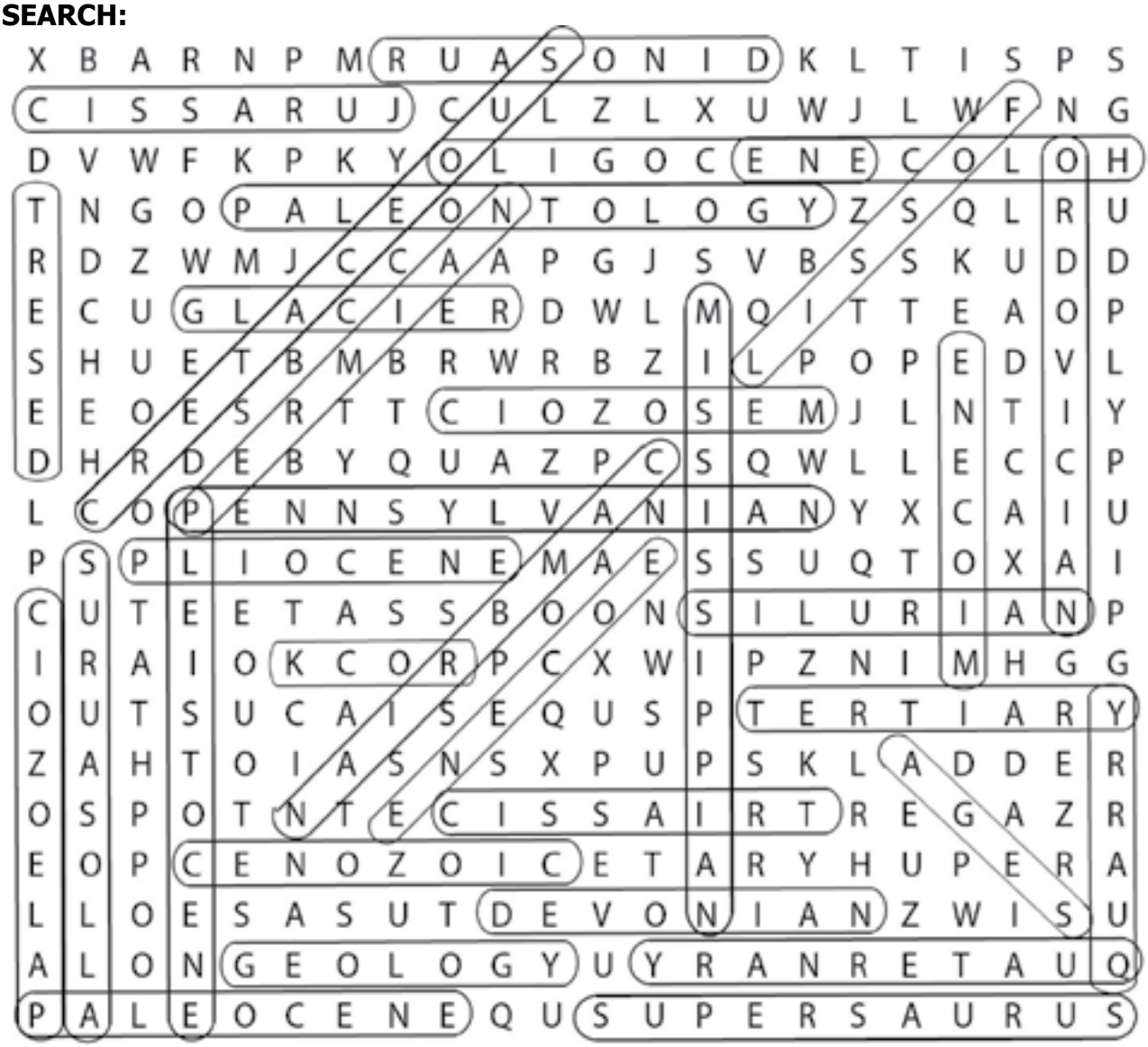
CLUE: F REPRESENTS THE LETTER T

ANSWER PAGE

STRATIGRAPHIC PUZZLE: From youngest to oldest, the stratigraphic sequence is:

B - volcanic eruption, igneous rock cuts through older layers
E - sedimentary rock layer buries eroded highland
F - deposition of sediments against eroded highland
G - two events, first folding to form a highland and then erosion
A - sedimentary rock layer
D - sedimentary rock layer
C - igneous rock

WORD SEARCH:



CODED MESSAGES: THE PRESENT IS THE KEY TO THE PAST

ONLY CHANGE IS CONSTANT

SCRAMBLED WORDS:

1. TRILOBITE
2. MAMMOTH
3. MASTODON
4. BRACHIOPOD
5. CRINOID
6. HORN CORAL
7. ECHINODERM
8. AMMONITE
9. FERN LEAF
10. FISH