

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 toe bone sticking out of a hillside on Dry Mesa, on the Uncompahgre National Forest. The bone was found in the pink and white colored rocks of the Jurassic Morrison Formation. The Joneses knew that the rocks in the Morrison Formation were deposited as sediment during the time that dinosaurs roamed the earth and were a good place to search for dinosaurs. They contacted Paleontologist Dr. Jim Jenson 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 site, and contacted the U.S. Forest Service office to ask for a permit to begin digging and searching for fossils.

Dr. Jenson, Professors Miller and Stadtman, and students from the university worked at the Dry Mesa quarry for over 20 years. They collected thousands of bones from 30 different creatures including dinosaurs, pterosaurs, crocodiles, turtles, lungfish and a shrew-like mammal. The bones were found all jumbled together in a 2 to 6-foot thick sedimentary rock layer. Paleontologists believe 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 most important finds were of two new species: Torvosaurus, which was the T. Rex of its day, but a few million years older than its cousin "T". Torvosaurus was 35 feet long and weighed 3 tons. The other exciting new find was named Supersaurus, an herbivorous dinosaur of the Diplodocus family. Two shoulder blades measuring 8 feet long were discovered, along with vertebra measuring 4 feet high by 5 feet long! Supersaurus was a long necked, four legged giant standing at 120 feet long and weighing 35-40 tons. WOW!

The fossils are now stored at the University in the Museum of Paleontology, where they are prepared and studied.



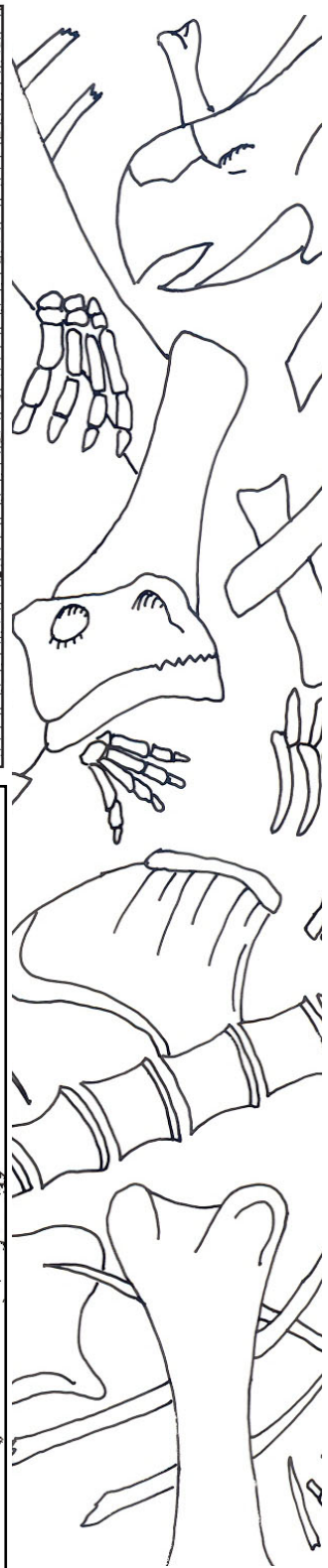
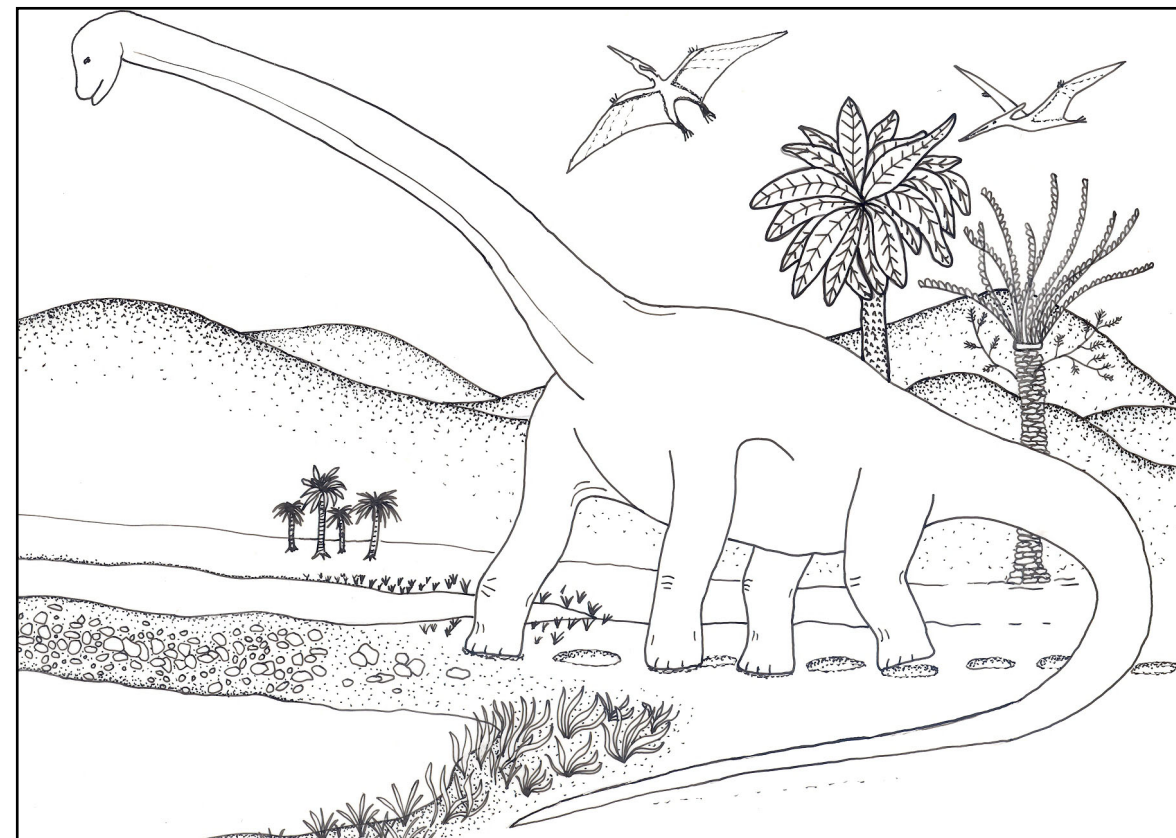
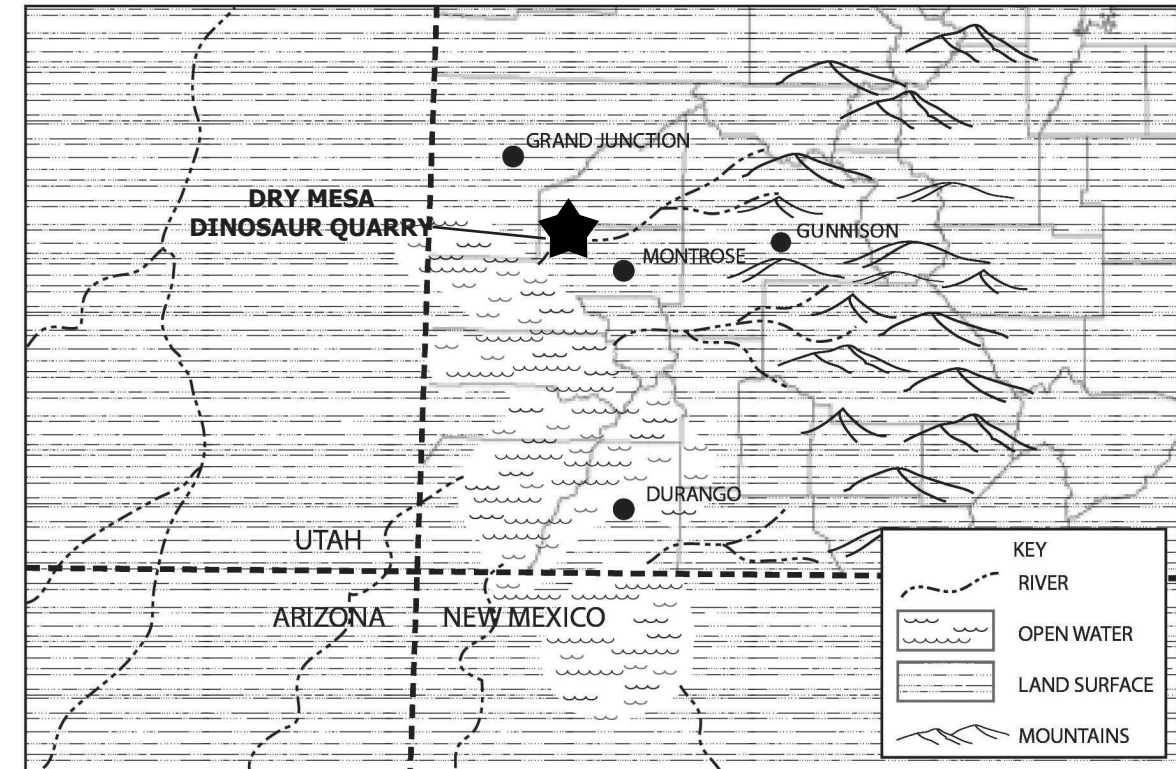
THE U.S. FOREST SERVICE ASKS YOU TO HELP PROTECT FOSSILS

Please help the Forest Service to care for our natural resources. The Forest Service Mission is "Caring for the Land and Serving People". Caring for the land includes being stewards of all our natural resources, including fossils. Fossils represent traces of past life and are unique and irreplaceable. They help us to understand the history of life on earth. Fossils can also help us to better understand ancient geography - where the mountains, streams, and oceans were located over geologic time - and the history and patterns of the earth's changing climate.

If you find bones of vertebrates (animals with a backbone), leave them where you find them and tell the ranger at the nearest Forest Service office. You can collect small amounts of fossils for personal use without a permit if they are invertebrates (animals with no backbone), such as shells or corals, as well as plant leaves or petrified wood.

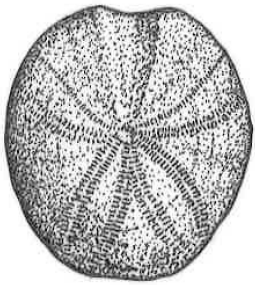
Want to get involved in a dinosaur dig? You can volunteer to help a professional paleontologist through the Forest Service's Passport in Time program. Visit our website at: <http://www.passportintime.com> to learn about projects!

JURASSIC MORRISON FORMATION AND THE DRY MESA DINOSAUR QUARRY



Fossil quarry site; the bones were found in a jumbled pile.

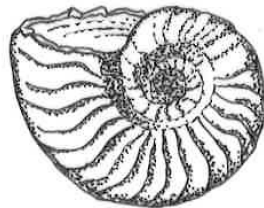
CRETACEOUS MANCOS SEAWAY: AROUND 90 MILLION YEARS AGO



Echinoderm



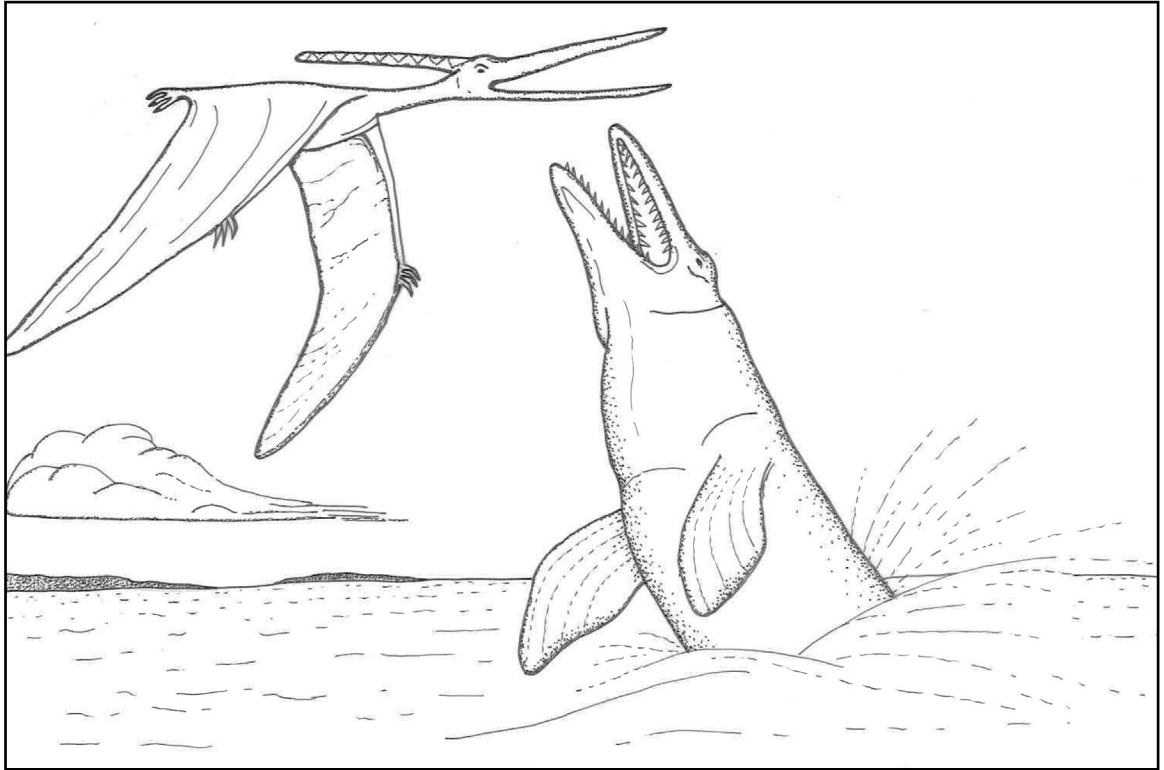
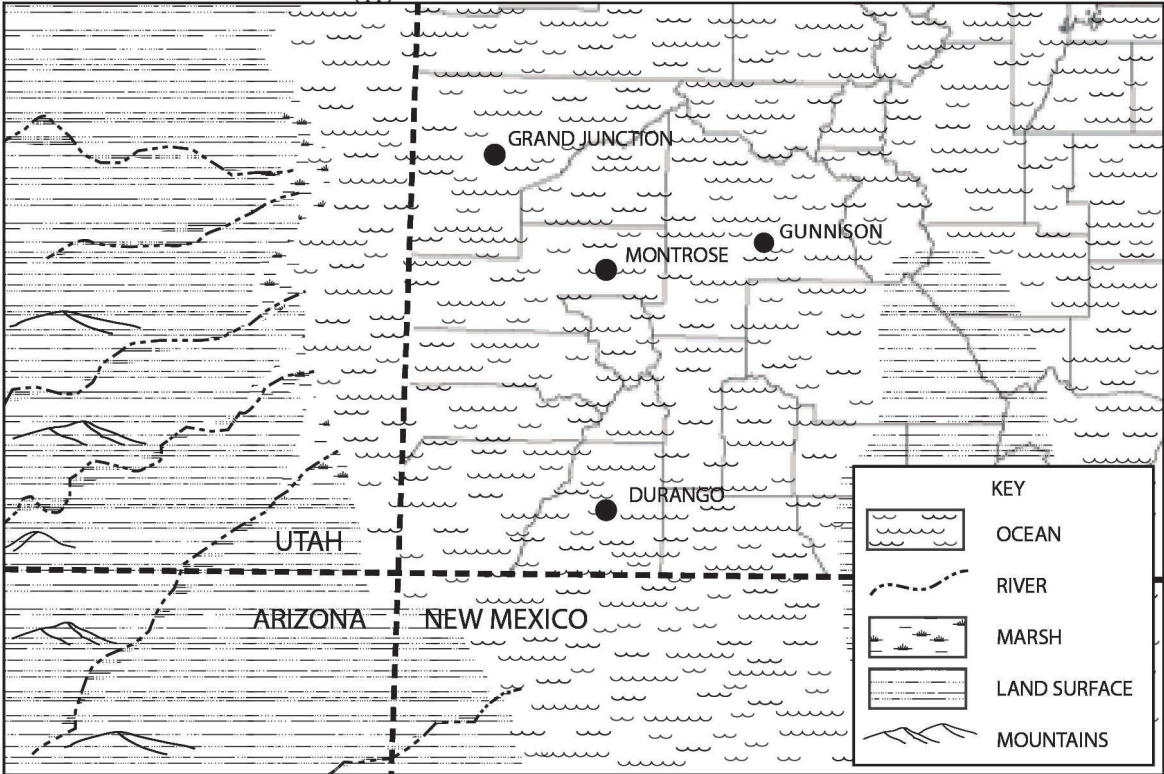
Shark's tooth



Ammonite

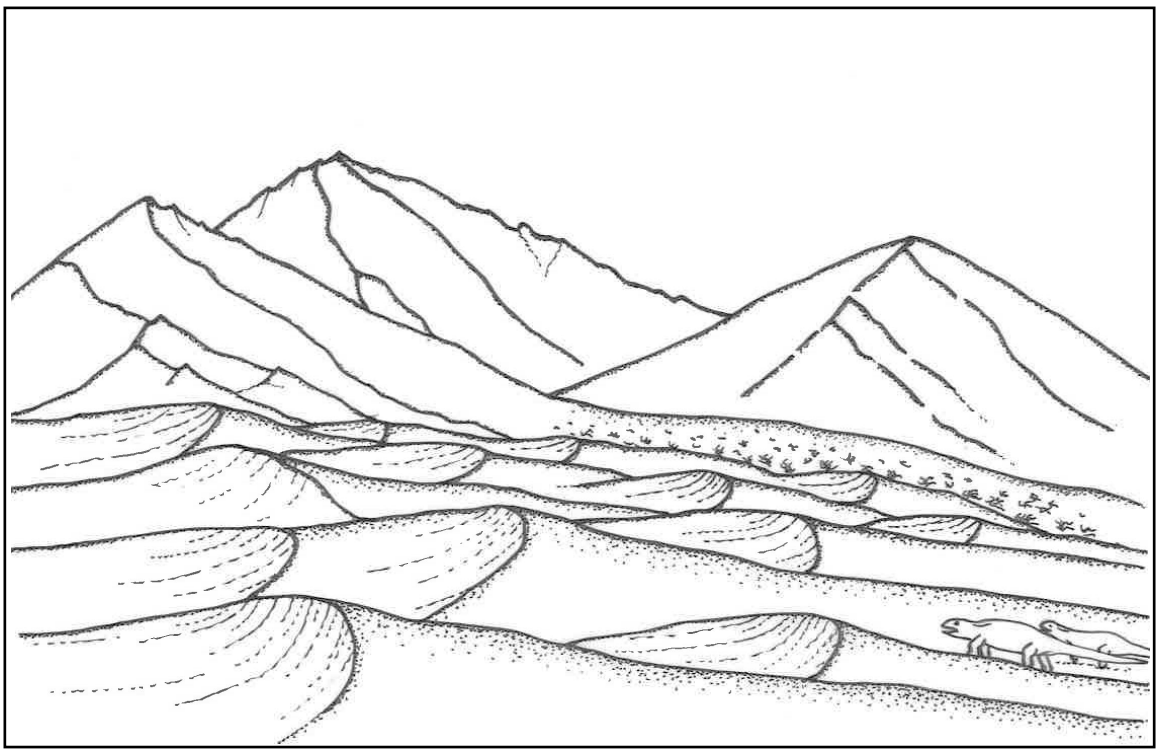
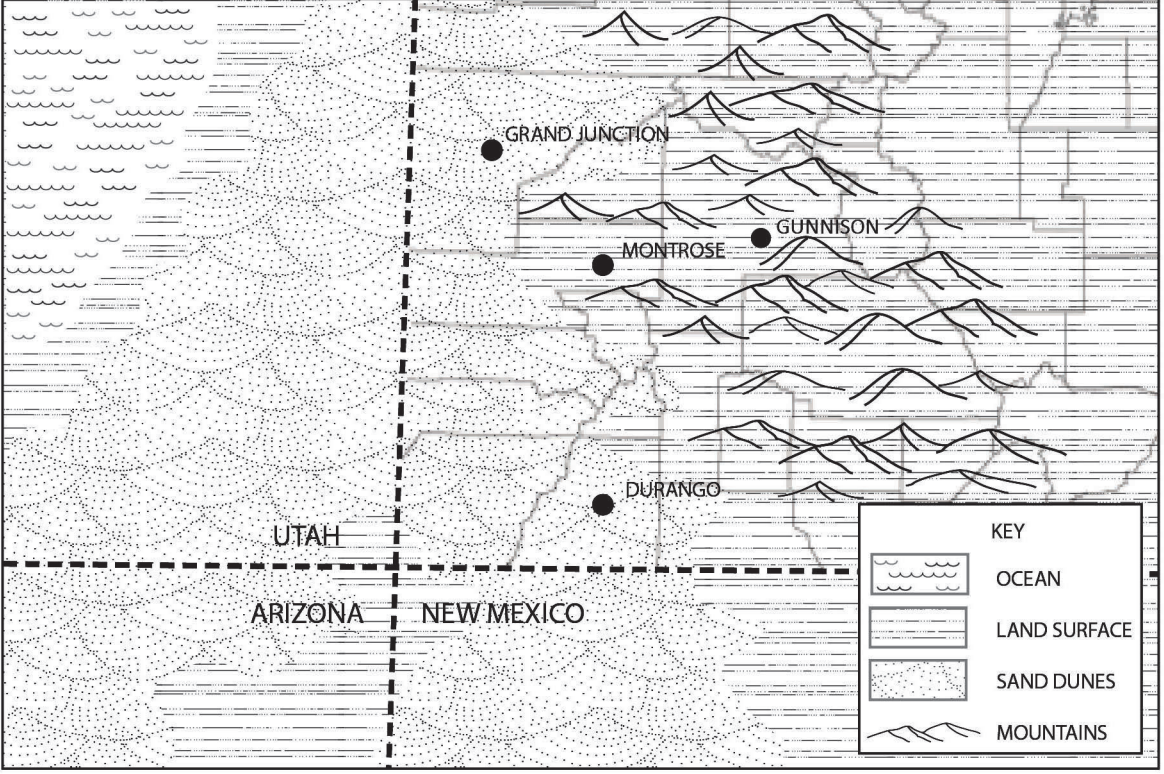


Pelecypod - clam



Around 105 million years ago the broad, open savannahs of the Morrison Formation gave way to the beach and shoreline deposits of the Dakota Sandstone which were later inundated by a vast shallow sea. Evidence of this sea is apparent as the Mancos Shale or “dobie” badlands around the Uncompahgre Valley and in the vicinity of Cortez and Mancos, Colorado for which it was named. The Cretaceous seas teamed with sea urchins (echinoderms), sharks, ammonites, and clams. In addition to these smaller sea creatures, great marine reptiles included the mosasaur shown here. Gradually, over time, the Cretaceous seaway retreated to the east and left shorelines, river deltas, and swamps. These swamp deposits became coal in the Mesaverde Formation.

JURASSIC PERIOD: 141 TO 195 MILLION YEARS AGO

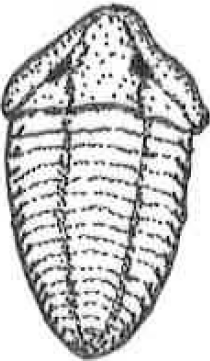
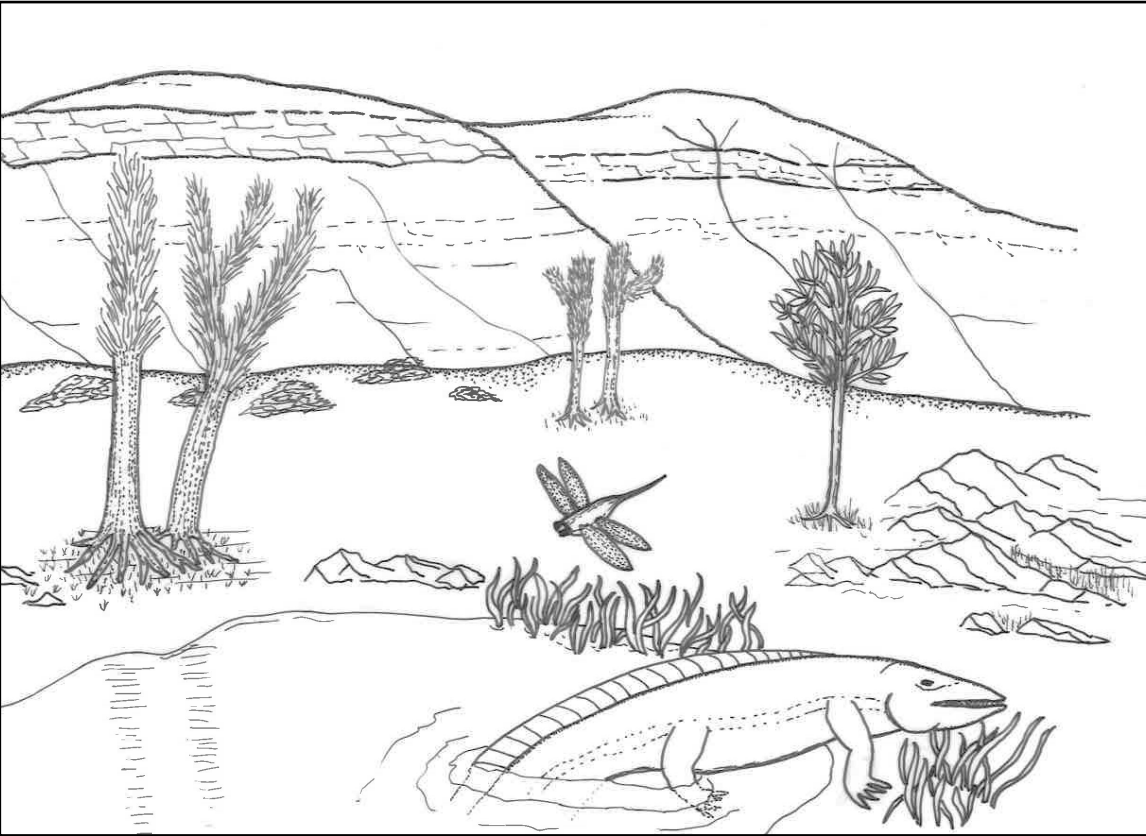
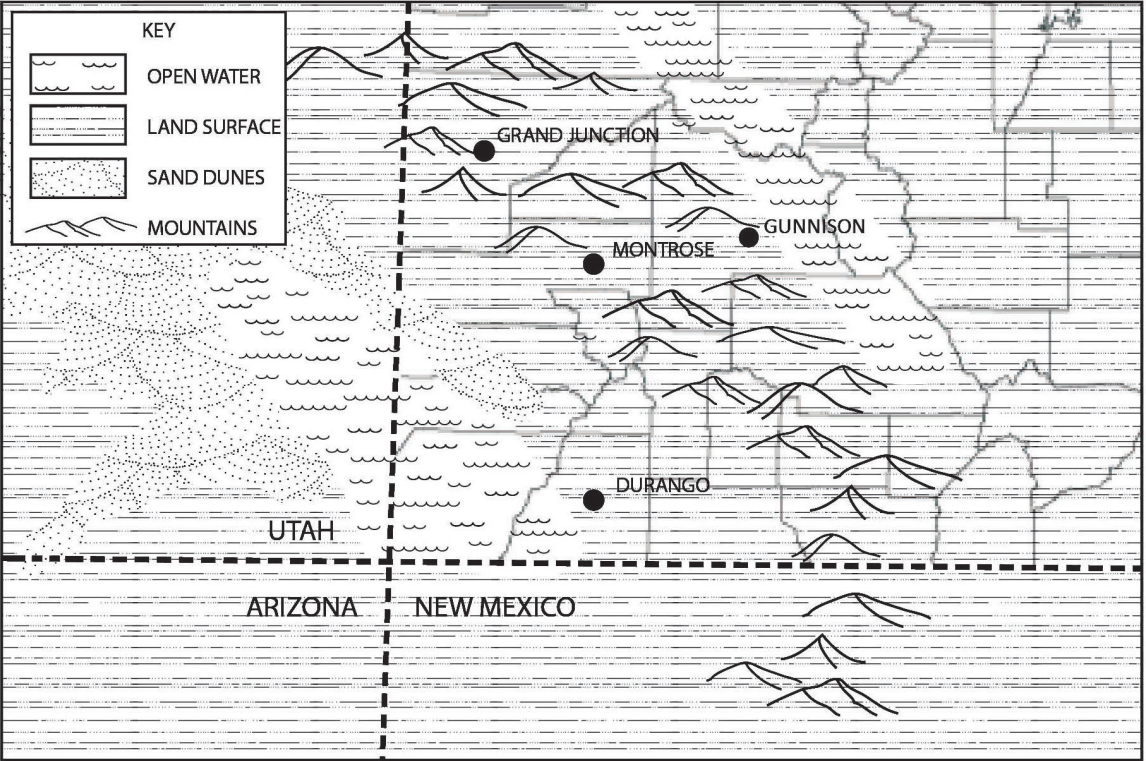


Around 195 million years ago western Colorado was covered by a vast desert with wind blown sand forming sand dunes. The soaring cliffs of Colorado National Monument are the solidified remains of these dunes as exposed in the massive Wingate Sandstone. While some mammals were in existence in the Jurassic, the earth belonged to the dinosaurs, which had increased in number and variety. Evolving from dinosaurs, the very first birds made an appearance in the Jurassic. In the oceans ammonites, snails, clams, and sea urchins and starfish (echinoderms) were present along with fish. Trilobites, however, had become extinct and were gone with the Paleozoic.

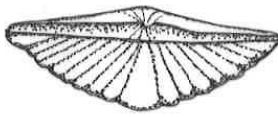


Dinosaur trackway - Sauropods (round) and Theropods (3-toed)

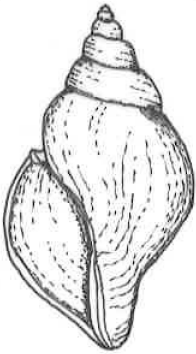
PENNSYLVANIAN PERIOD: 280 TO 310 MILLION YEARS AGO



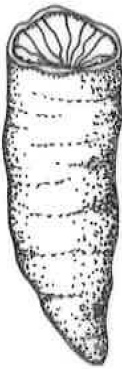
Trilobite



Brachiopod



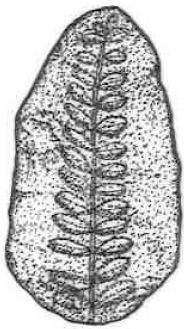
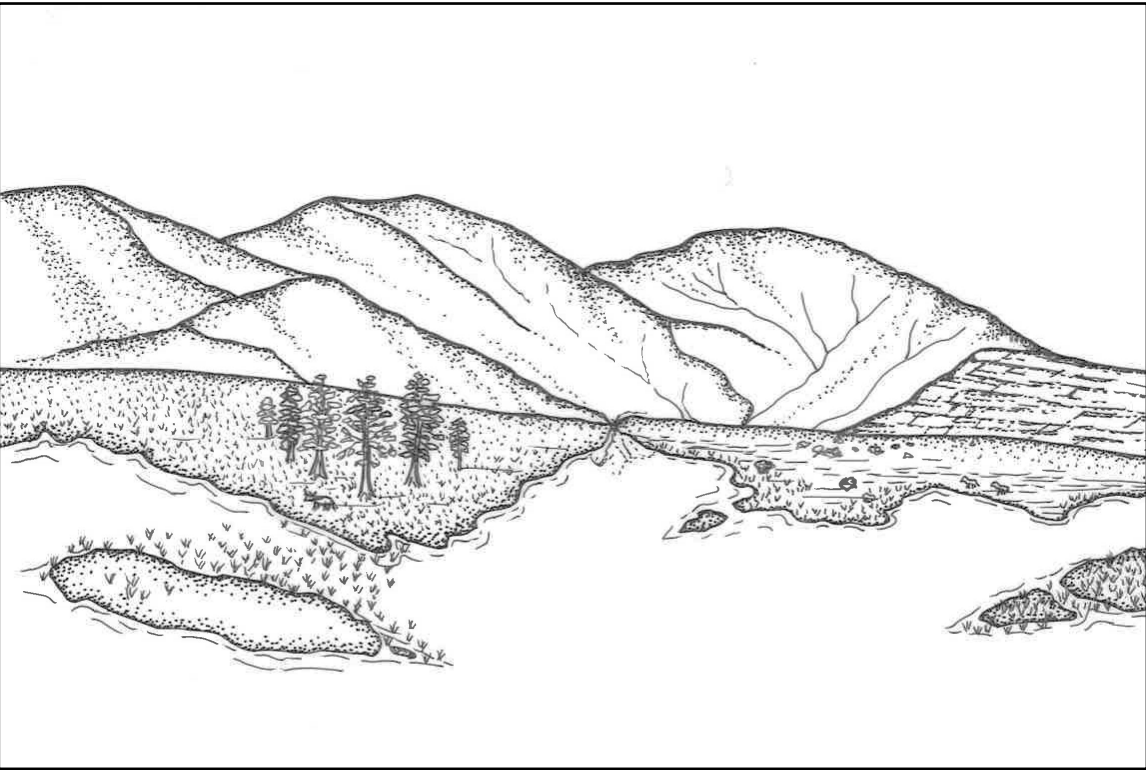
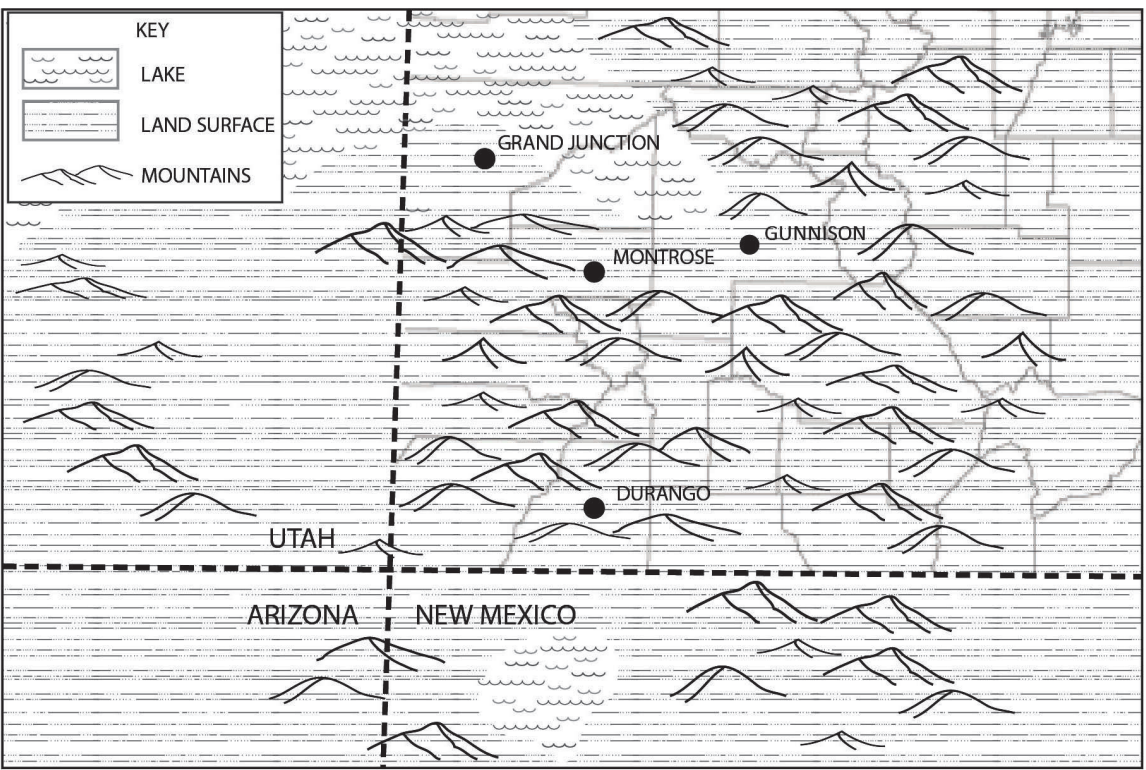
Gastropod



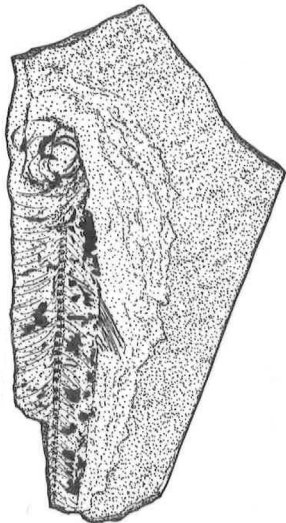
Horn Coral

Around 300 million years ago, the oceans had retreated and southwest Colorado was the site of an old mountain range called the Uncompahgre Highlands. Basins surrounding the mountain range were filled with sediment eroded from the mountains. Plants were growing on the land by then and animals had begun to emerge 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 2 1/2 feet across!

EOCENE EPOCH: 36 TO 58 MILLION YEARS AGO



Imprint of fern



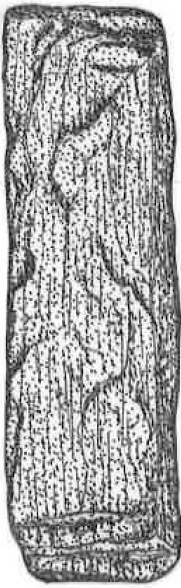
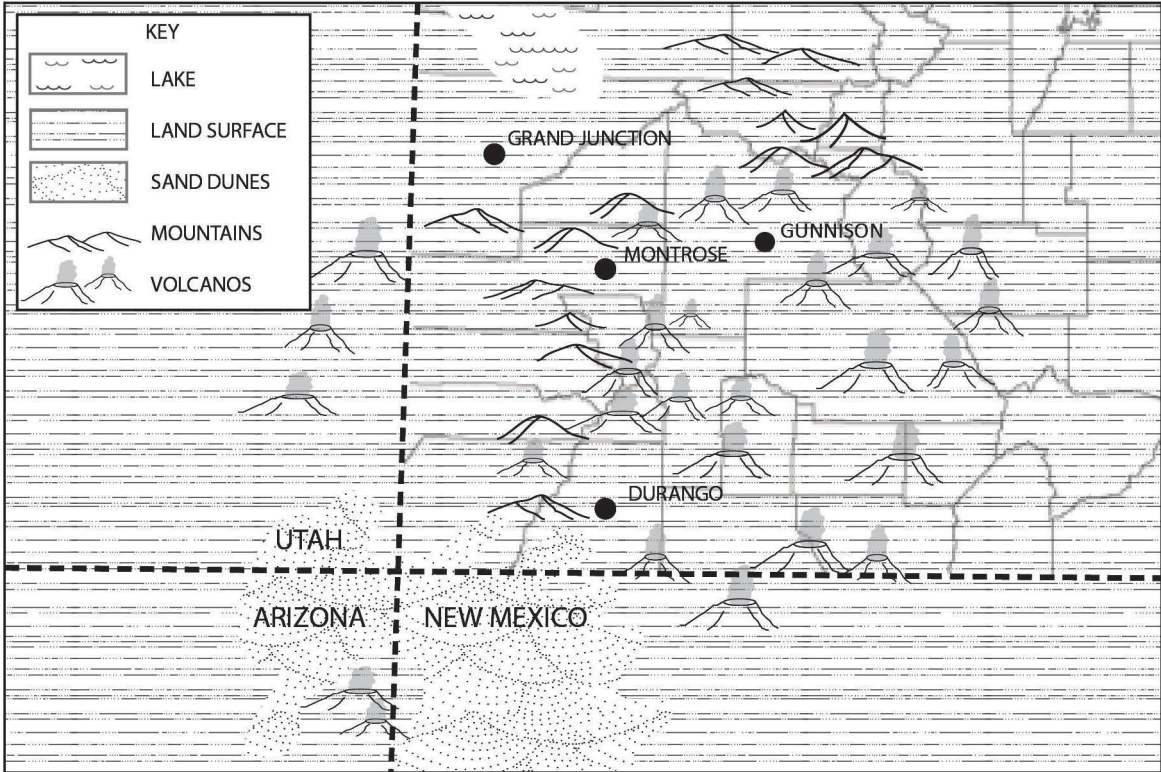
Fossil Fish



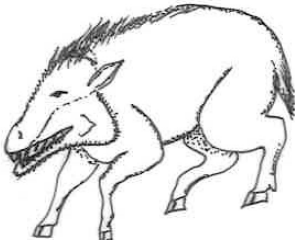
Petrified wood

At the close of the Mesozoic (Age of Dinosaurs) and the start of the Cenozoic (Age of Mammals) a great period of mountain building, called the Laramide Orogeny, took place. By the time of the Eocene, mountains were eroding and basins between mountains were filling with sediment eroded from the mountains. Lakes formed in these basins and became filled with fine grained silt, such as the Green River Formation. The lake deposits of the Green River Formation contain fossils of whole fish as well as individual scales. Other fossils include leaves, insects, and petrified wood. **Fun Fossil Fact:** The oldest known flying mammal fossil, a bat, with food still intact inside its body was discovered in the Green River Formation.

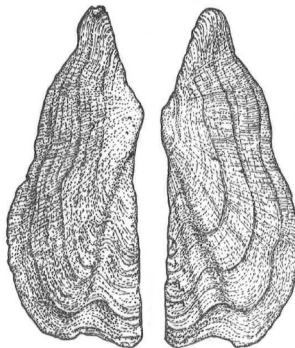
OLIGOCENE EPOCH: 22.5 TO 36 MILLION YEARS AGO



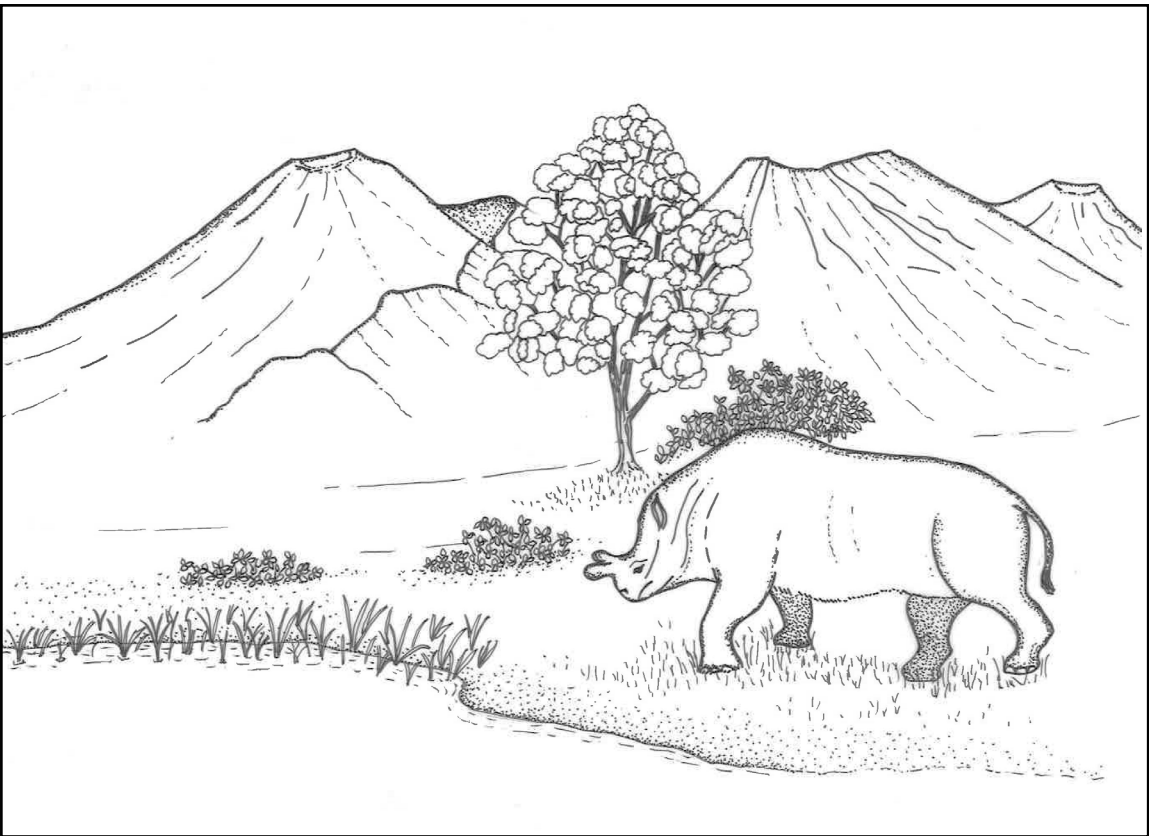
Fossilized wood



Entelodont

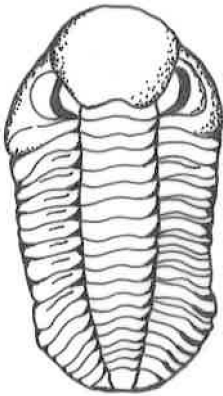
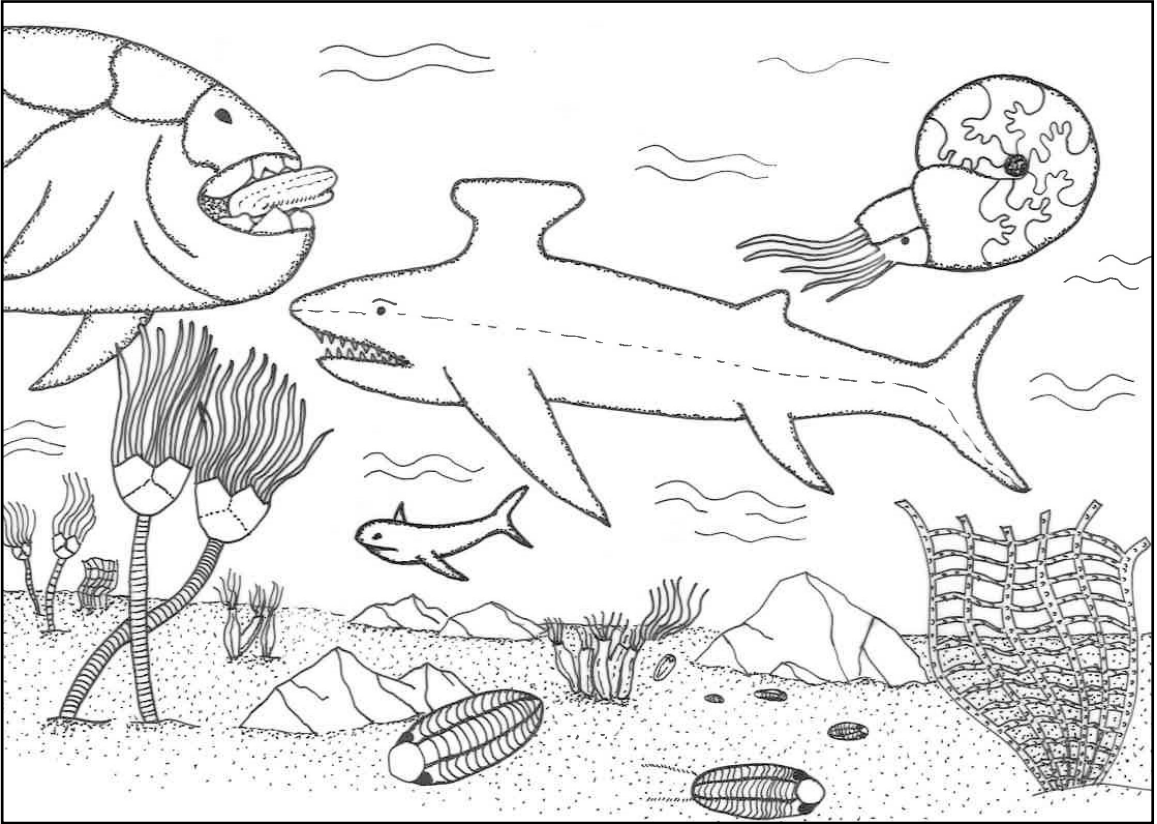
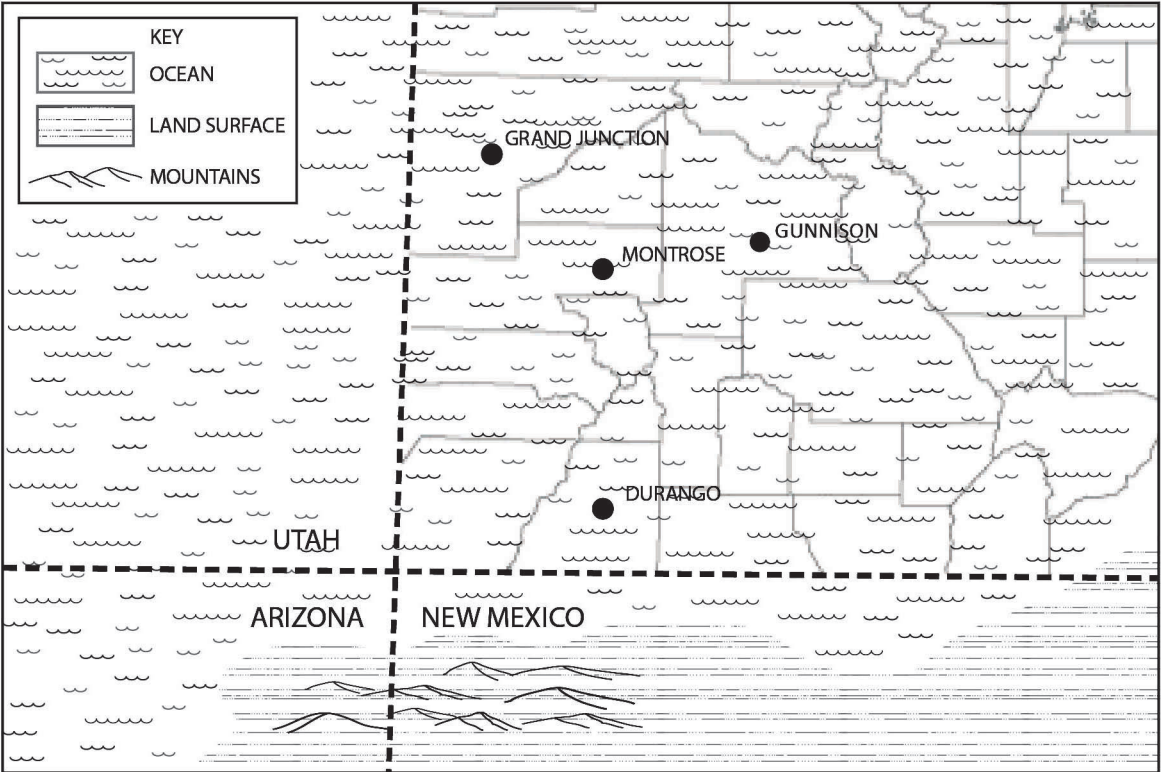


Paired Pelecypods

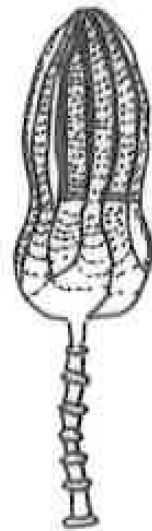


During the Oligocene, around 30 million years ago, volcanoes were scattered across southwestern Colorado. The eruption of these volcanoes was violent with ash and debris ejected across the region. Great mammals including rhinos, camels, and elephants walked the land.

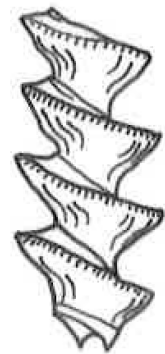
MISSISSIPPIAN PERIOD: 310 TO 345 MILLION YEARS AGO



Trilobite



Crinoid



Archimedes
Bryozoan

During the Mississippian Period, southwest Colorado was covered by an ocean that teemed with life. Early sharks with a strange looking dorsal fin swam along with ammonites, a relative of squids with great coiled shells. Trilobites, a segmented creature crept along the ocean floor. Although looking like plants, crinoids were actually animals attached to the ocean floor. Archimedes bryozoan, similar to coral, grew in corkscrew spirals. **Fun Fossil Fact:** Ammonites differed from snails in that their shells contained chambers. The edges of the chambers can be exposed on the sides of the shells as "suture patterns". These patterns could be quite simple curved surfaces or very wavy and complex.

THE PRESENT IS THE KEY TO THE PAST

This is one of the first lessons learned by geologists. What it means is that the geologic events we observe today likely took place in the past and shaped our world in a manner similar to what we can observe today. Volcanoes, floods, ocean tides, winds, gravity, as well as sedimentation, erosion, and metamorphism have likely behaved in a similar manner throughout time. Our world 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 of the events that have occurred in the past.

The driving force of all of this change is “plate tectonics”, the movement of large plates of the Earth’s crust which results in the formation of vast mountain ranges and the creation of new crust. As the plates slowly move across our globe, volcanoes and earthquakes bear witness to the immense power at play.

Other forces of change include glacial ice advancing then melting; wind and water eroding mighty mountains until they are flat; basins filling with rock and debris washed down from highlands. Only change is constant in our world.

Fossils preserved in rock provide clues as to what the environment was like and what kind of plant and animal life existed during all of these changes. Tropical fern plants suggest a warm, moist environment while shark's teeth, shells, and fish fossils indicate that oceans once covered a portion of the earth. In Colorado, our home has been at the bottom of an ocean several times, seen the creation and erosion of a vast mountain range eons before the San Juan Mountains were formed, and has been covered by ice. This story is told in the rocks and fossils around us.

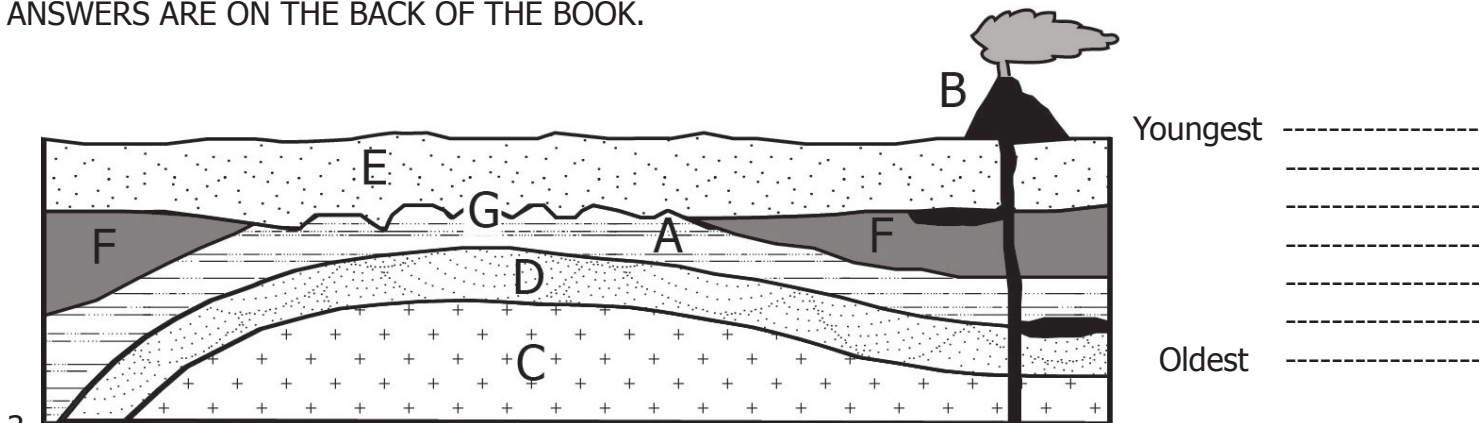
STRATIGRAPHIC PUZZLE

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

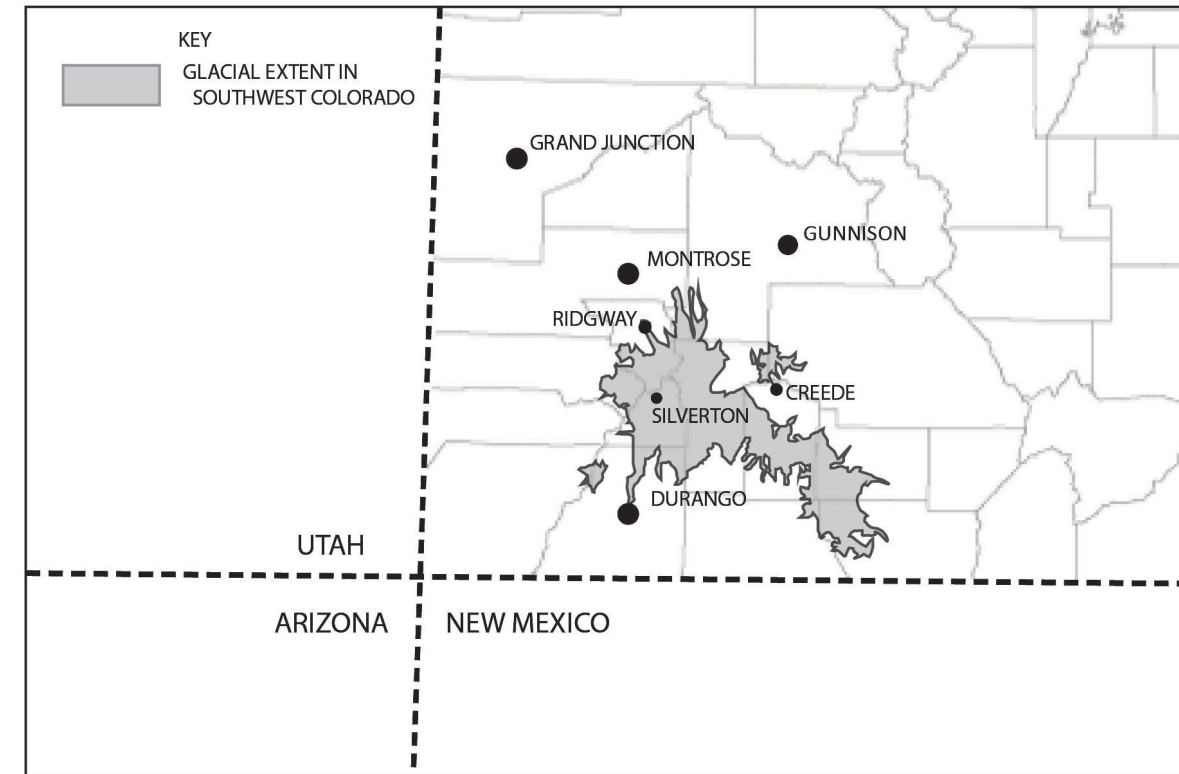
Geologists know that the oldest sedimentary rocks are at the bottom and younger layers of sedimentary rocks are above them. The sediments, such as grains of sand and particles of clay, are laid down in a generally horizontal position. The sediments are then compressed by more sediment laid down on top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

These generally horizontal layers can become changed over time by events occurring inside the earth and also on the surface of the earth. Examples of processes that can occur include: volcanic activity in which younger rock cuts through older rock, faults which break through rock layers, and folding or tilting of rock. In addition, surface processes such as erosion by water or wind, and landslides 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.

ANSWERS ARE ON THE BACK OF THE BOOK.



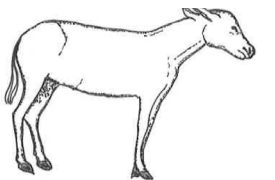
PLEISTOCENE, THE ICE AGE: 10,000 YEARS TO 2 MILLION YEARS AGO



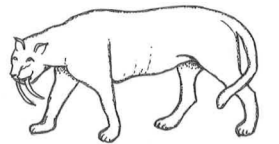
Dire Wolf



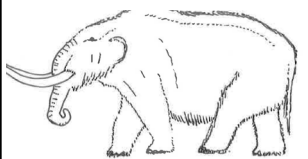
Bison



Equus - Wild Horse



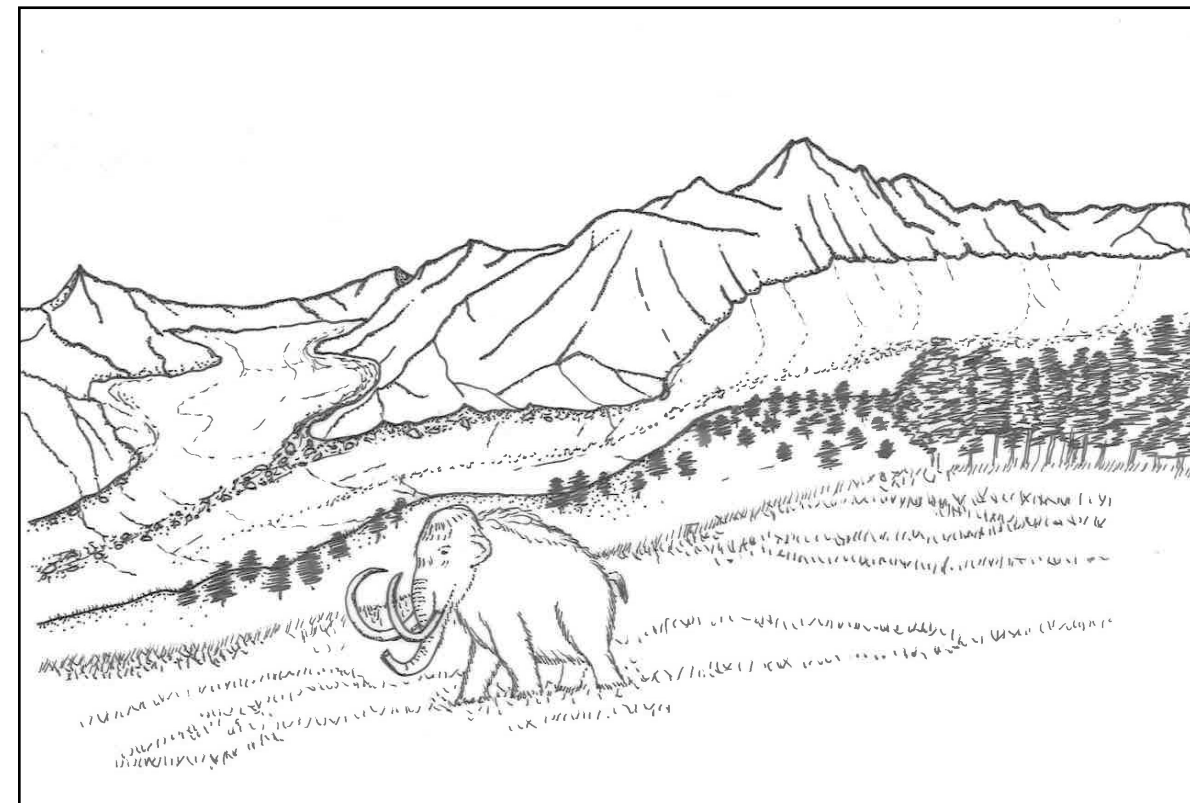
Sabertooth Cat



Mastodon



Short-faced Bear



The Pleistocene is called The Ice Age and for good reason. Across the North American continent, a vast ice sheet descended down from Canada. In the Rocky Mountains, ice collected along mountain ranges and began to flow down valleys as vast glaciers. The map shows the approximate extent of the ice in the San Juan Mountains. Ice didn't completely cover the mountains but, in places, only the highest peaks would show. Animal life was vastly different from present day wildlife and included elephant like mammoths and mastodons, giant ground sloths, saber-tooth cats, and early horses. **Fun Fossil Fact:** Horses were extinct on the North American continent near the end of the Ice Age and were reintroduced to North America by European explorers ten thousand years later.

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

THE PHANEROZOIC EON

The Phanerozoic Eon is the last 1.6 inch on the 12-inch ruler on the previous page. It is divided into 3 eras which are further divided into periods as shown in the table, below. We know more about the Phanerozoic Eon than any other time in Earth’s history. Why? Life exploded at the start of the Phanerozoic, and left fossils behind. Geologists have put together the history of the Earth by studying the fossils and the rock layers. Geologists know that limestone is deposited on an ocean floor, sand collects on a beach or desert, coal is formed in swamps. From this and other information, geologists have recreated the history of the earth. The history of our part of Colorado is summarized below.

The pages that follow show what life and the landscape in Colorado might have looked like through the ages of our Earth. Suggestion: color the maps and dioramas on the following pages. Learn what the environment was like in Western Colorado and the Four Corners Region.

ERA	PERIOD / EPOCH	SYMBOL	AGE	GEOLOGIC EVENTS IN COLORADO
CENOZOIC AGE OF MAMMALS	QUATERNARY	Qu		
	HOLOCENE		PRESENT TO 10,000	THE "RECENT", COMING OF MAN IN NORTH AMERICA
	PLEISTOCENE		10,000 TO 2 M.Y.	THE ICE AGE, FOUR MAJOR ICE ADVANCES
	TERTIARY	T		"REVERSE DEPOSITION" SEQUENCE OF DEPOSITION FOLLOWED BY INCISION AND DOWN CUTTING
	PLIOCENE		2 M.Y. TO 6 M.Y.	MIOCENE - PLIOCENE PERIOD OF UPLIFT, 5000 FEET TO PRESENT ELEVATIONS, SUBSEQUENT INCISION OF RIVER SYSTEMS
	MIOCENE		6 M.Y. TO 22.5 M.Y.	
	OLIGOCENE		22.5 M.Y. TO 36 M.Y.	VOLCANIC ACTIVITY IN SAN JUANS,
MESOZOIC AGE OF DINOSAURS	EOCENE		36 M.Y. TO 58 M.Y.	VAST LAKES IN WESTERN COLORADO AND IN UTAH, DEPOSITION OF OIL SHALE DEPOSITS
	PALEOCENE		58 M.Y. TO 65 M.Y.	LARAMIDE OROGENY LONG EPISODE OF MOUNTAIN BUILDING CREATING PRESENT DAY STRUCTURE OF THE ROCKIES
	CRETACEOUS	K	65 M.Y. TO 141 M.Y.	THE SEAS CAME IN, THE SEAS WENT OUT - DEPOSITION OF MARINE, NEAR SHORE, AND LAGOON (COAL) DEPOSITS
	JURASSIC	J	141 M.Y. TO 195 M.Y.	TERRESTRIAL DEPOSITION - FLOODPLAIN, MARSH, DUNE
PALEOZOIC TERRESTRIAL LIFE FISH LIFE EXPLODES IN THE SEAS	TRIASSIC	Tr	195 M.Y. TO 230 M.Y.	CONT. EROSION OF MTNS., DEPOSITION ON FLOODPLAINS, DELTAS
	PERMIAN	P	230 M.Y. TO 280 M.Y.	CONT. EROSION OF MTNS., DEPOSITION OF EOLIAN RED BEDS
	PENNSYLVANIAN	P	280 M.Y. TO 310 M.Y.	EROSION OF MTNS., SALT BASINS BETWEEN RANGES
	MISSISSIPPIAN	M	310 M.Y. TO 345 M.Y.	COLORADO OROGENY UPLIFT OF ANCESTRAL ROCKIES INCLUDING THE UNCOMPAGRE HIGHLANDS (NOT TO BE CONFUSED WITH THE UNCOMPAGRE PLATEAU)
	DEVONIAN	D	345 M.Y. TO 395 M.Y.	MARINE DEPOSITION
	SILURIAN	S	395 M.Y. TO 435 M.Y.	MARINE DEPOSITION AND EROSION
	ORDOVICIAN	O	435 M.Y. TO 500 M.Y.	MARINE DEPOSITION
PRECAMBRIAN	CAMBRIAN	Є	500 M.Y. TO 600 M.Y.	
		pЄ		METAMORPHOSED "BASEMENT" ROCK

INTRODUCTION

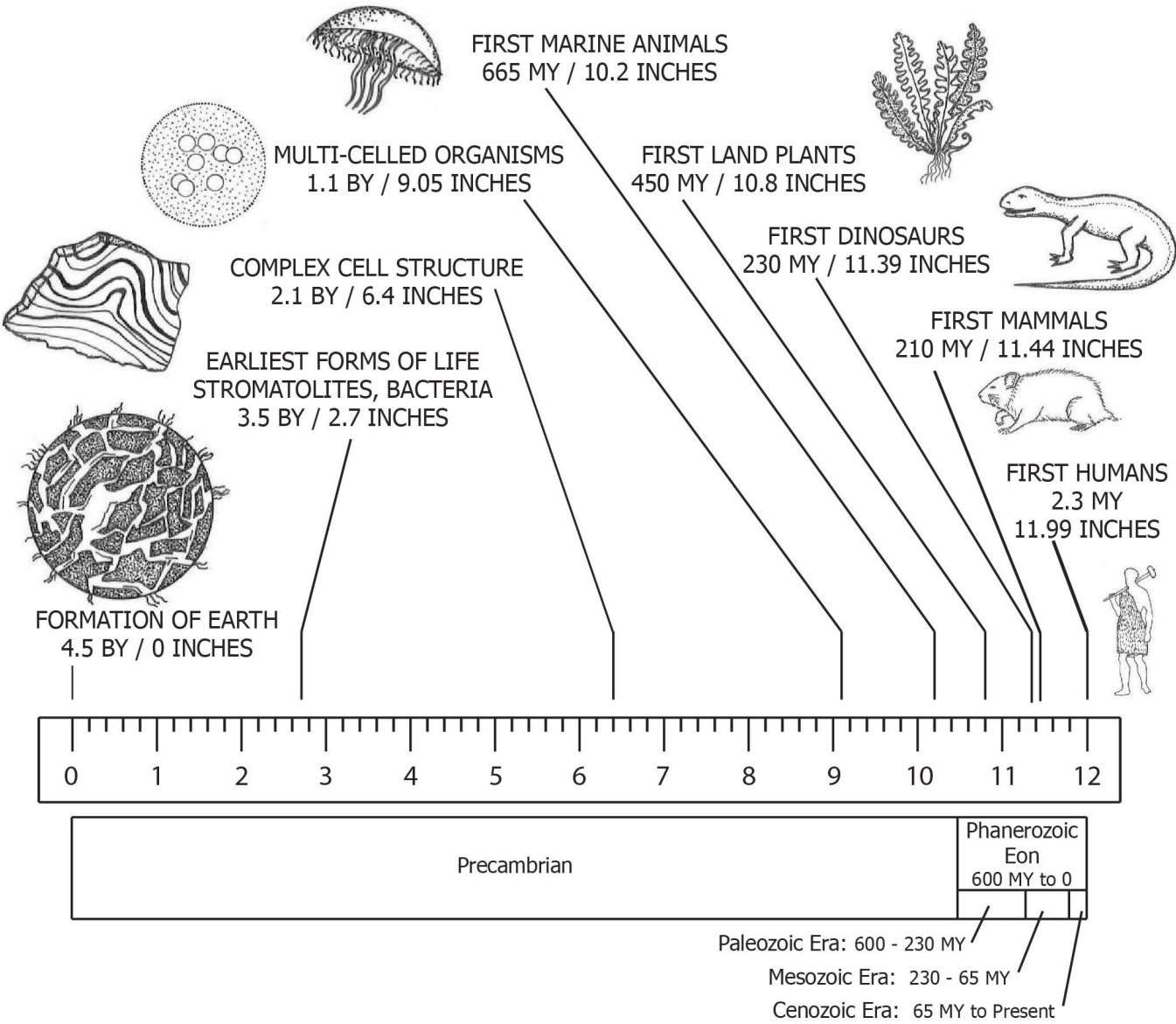
Okay, so Supersaurus didn't fly through Jurassic skies wearing a cape, but you probably knew that. A gigantic dinosaur named Supersaurus did live here, and the rest of the information in this activity book is true. The earth is very, very old, around 4,500,000,000 years old. Lots of strange creatures swam, crawled, walked, and flew across our corner of Colorado before the present landscape came to be. Their story is told in the fossils they left behind. Information about the environment they lived in is told in the rock layers. As you color the pages and solve the puzzles, you will learn about the remarkable geologic story of our home.

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, abbreviations for billion years and million years are used, as follows:

- 1 BY = 1 billion years = 1,000,000,000 years
- 1 MY = 1 million years = 1,000,000 years

Major events in the history of the earth are shown above the ruler. The ages of geologic eons and eras are shown below the ruler.



CODED MESSAGES

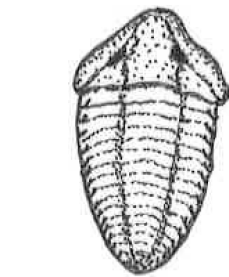
Try to decipher the messages below. Each letter in the alphabet represents another letter. Write your answer below the code. A clue is given at the bottom of the page.
ANSWERS ARE ON THE BACK OF THE BOOK.

FRL BWLKLDF YK FRL OLZ FG FRL BMKF

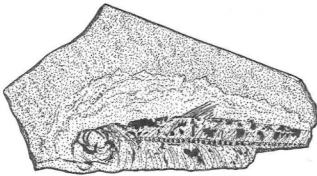
GDCZ VRMDQL YK VGDKFMDF

SCRAMBLED WORDS

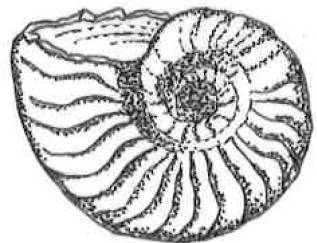
These fossil names are scrambled. Try to spell the fossil. As a hint, each fossil is shown in the pictures.
ANSWERS ARE ON THE BACK OF THE BOOK.



1. TTLBIOREI _____



2. TOMMMAH _____



3. DOOSNAMT _____

4. DROCOBAHIP _____

5. ROCNIID _____

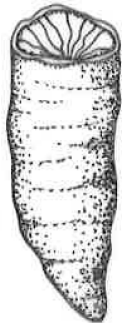
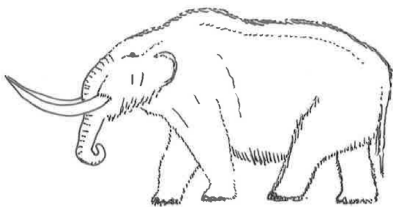
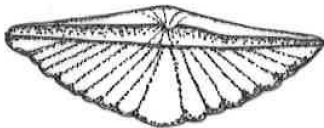
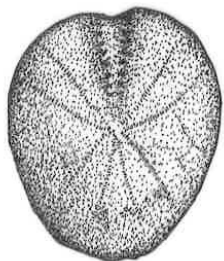
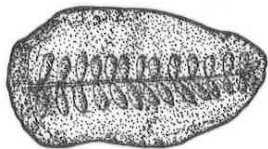
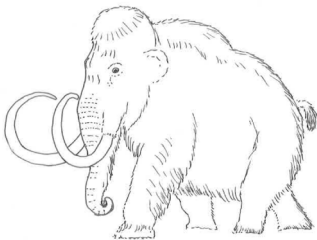
6. NOHR RLCOA _____

7. RMNOCEEDIH _____

8. AOENMMIT _____

9. NRFE AELF _____

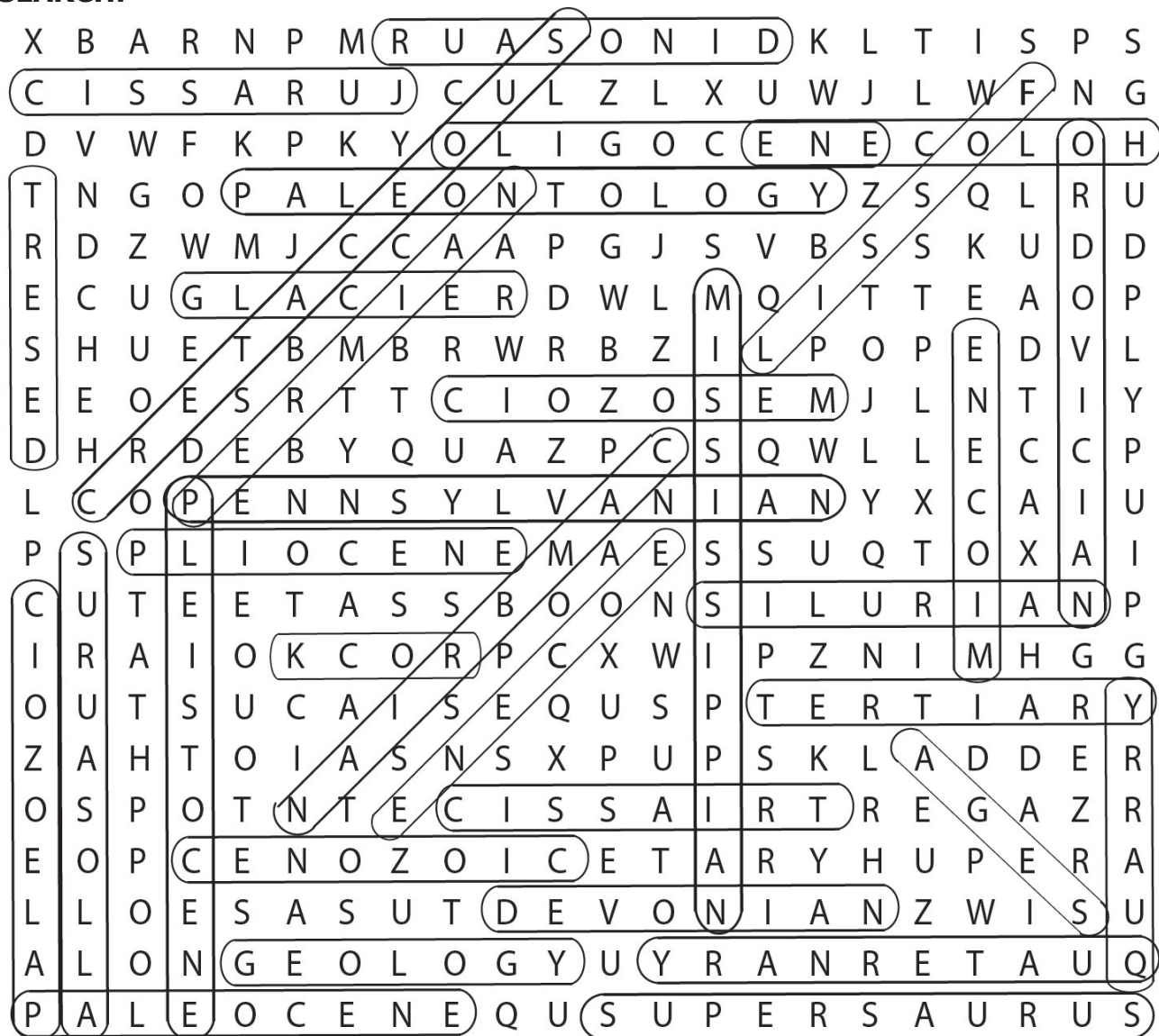
10. HFSI _____



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:



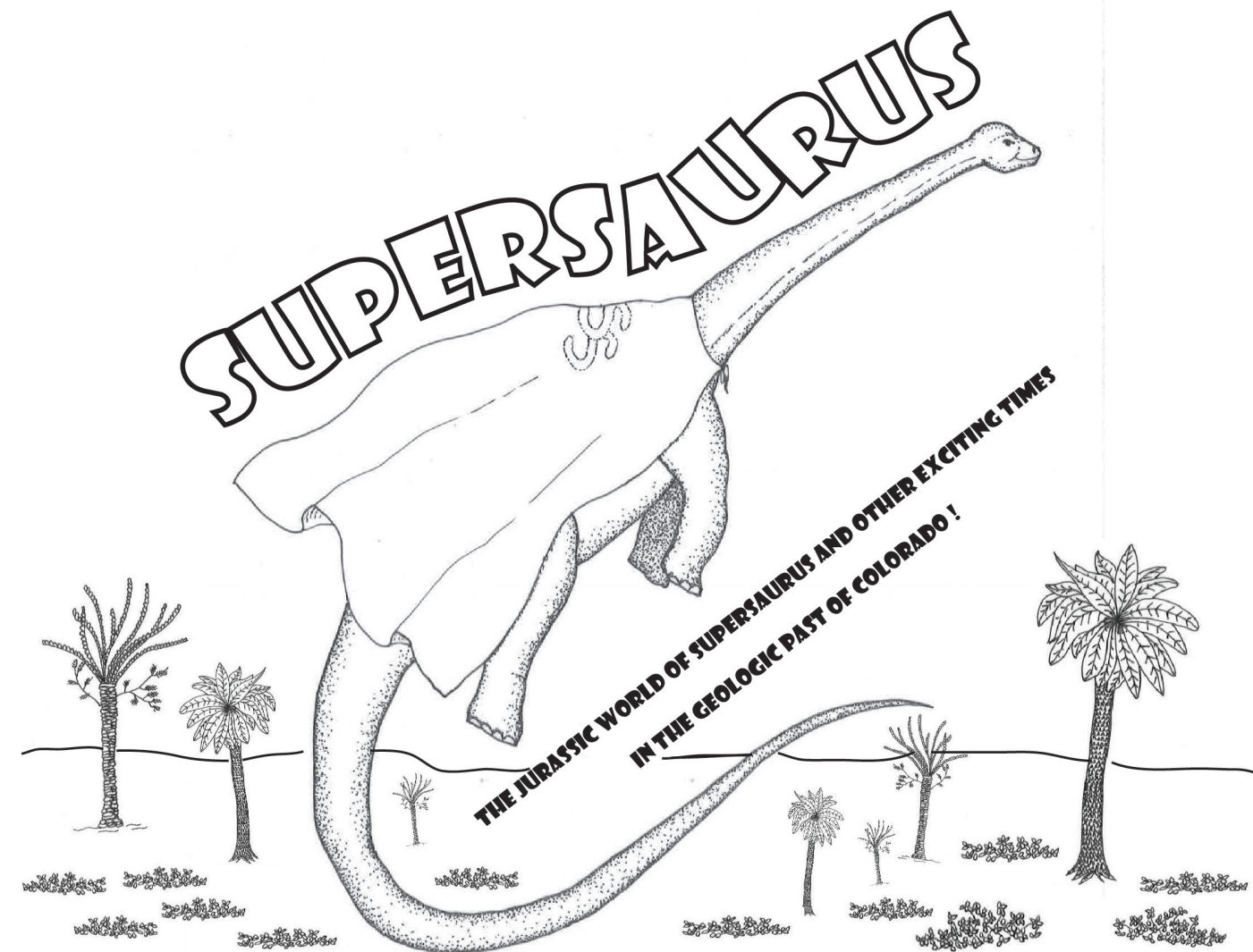
CODED MESSAGES:

THE PRESENT IS THE KEY TO THE PAST

ONLY CHANGE IS CONSTANT

SCRAMBLED WORDS:

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



SEE

**COLORADO COVERED BY
AN ANCIENT OCEAN!**

**GLACIERS AND A
LANDSCAPE WHERE
MAMMOTHS WALKED!**

**COLORADO COVERED
BY A
VAST DESERT!**

**GIANT
MAMMALS AFOOT IN
COLORADO!**

LEARN

**HOW TO DECIPHER STRATIGRAPHY!
ABOUT DINOSAUR EXCAVATIONS!**

EXPLORE

COLORADO'S GEOLOGIC PAST!

**BUT WAIT,
THERE'S MORE!**

**COLORING PAGES!
PUZZLES!**



Illustrations and graphic design by Nancy Lamm