# SELF-GUIDED TOUR BOOK

GEOLOGY MUSEUM

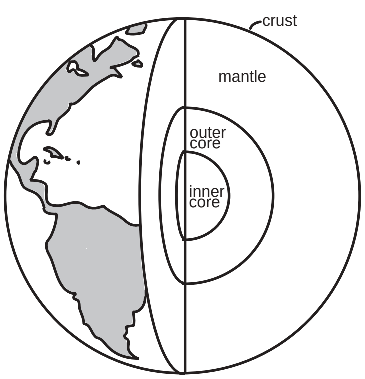
Thank you for visiting!

Please return this book to the front desk.

*Welcome to the University of Wisconsin – Madison Geology Museum! As you're moving through the museum, please check the upper left-hand corner of the display cases for exhibit numbers corresponding to entries in this booklet.*

## THE GLOBE

***Exhibit 1.*** If the earth were reduced to the size of this six-foot globe, its topography would be less bumpy than the skin of an orange. Therefore, the relief on the globe has been greatly exaggerated in order to show the features on the earth's surface more clearly.




Our earth has layers like a hard boiled egg. The outermost layer is called the crust and that's what we are standing on right now. It includes the highest mountain and the ocean floor, too. The crust is made of rock and is thin like the shell of an egg. The earth's crust sits on a layer called the mantle. The mantle, while having the composition of rock, is under pressure and is at higher temperatures so that it deforms plastically, meaning that it can move and bend, but slower than taffy or molasses. The center of the earth is called the core. The outer core is very hot and molten, but the inner core is solid and made of nickel and iron. Although the inner core is very hot like the outer core, the increased pressure is so great, that it remains solid.

*Which is spinning faster, our globe or the earth?
*What causes the change of seasons?
*As seen from above the North Pole, is the earth spinning clockwise or counterclockwise?
*Find the following features on the globe.

A. Madison, Wisconsin
B. San Andreas Fault, west coast of the U.S.
C. Hawaii, a chain of volcanic islands in the Pacific Ocean
D. Mariana Trench, deepest ocean trench, up to 35,840 ft. deep
E. Japan, a volcanic island arc in the east Pacific Ocean
F. Himalayas, a mountain range that is forming as India collides with Asia. Mt. Everest is over 29,000 ft above sea level.
G. East African Rift, running north-south through East Africa
H. Mid-Atlantic Ridge, a divergent plate boundary
I. Antarctica, a ice-covered continent at the South Pole

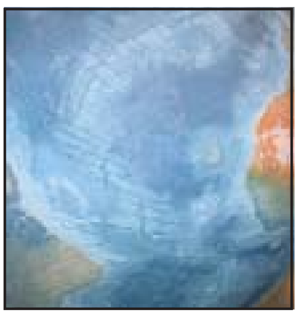
*Look in the back for answers!*

**GEO-EXPLORER**

# PLATE TECTONICS

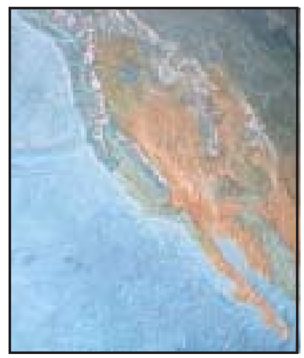
The crust is divided into approximately 12 plates (or pieces), which move between 1 and 18 centimeters per year due to convection currents in the mantle. Plate boundaries are of intense earthquake and volcanic activity. There are three types of plate boundaries:

| PLATE TYPE | | EXAMPLE |
|---|---|---|
| Divergent | ←→(moving apart) | Mid-Atlantic Ridge<br>East African Rift |
| Convergent | →←(moving together) | West Coast of South America<br>Mariana Trench |
| Transverse | ⇆(sliding past) | San Andreas Fault |



Mid-Atlantic Ridge

South America



San Andreas Fault

Approximately 200 million years ago, all of the continents were together and formed the supercontinent Pangaea (pronounced *Pan* ***gee****-a*, meaning the united land). Plants and animals could disperse easily across this huge landmass. This is why we find dinosaur remains on every continent today. *Read the entry for Exhibit 47 to learn how Mesosaurus fossils provide evidence for plate tectonics.*


## Did you know?

*What is geology, and what is it not?*

Geology is the study of the earth and includes rocks, minerals, earthquakes, volcanoes, even other planets! In our museum, we have a lot of paleontology, also. Paleontology is the study of ancient, non-human life. Archeology is the study of human remains – we don't have any archeology in our museum, you can visit the State Historical Museum if you'd like to learn more about archeology.

# ROCKS AND MINERALS

***Exhibit 2.*** Rocks and minerals are often confused and thought of as being the same thing. However, minerals are the building blocks, or ingredients, of rocks. For example, when you make cookies, many ingredients are required, such as flour, sugar, butter, and chocolate chips. If you change the ingredients or their amounts, you end up with a different kind of cookie: a snickerdoodle instead of a chocolate chip cookie. Minerals are the *ingredients* of rocks. It's the types and amounts of minerals present that determine what kind of rock it is. Most of the display cases in this room contain mineral specimens, allowing you to see the range of possibility for different rocks to be formed.

Geologists use many observations in order to identify minerals. As you look in case 5, you'll notice important criteria such as color, hardness, luster, and cleavage.

***Exhibit 3.*** Quartz is a mineral that can come in many different colors due to impurities in its crystal structure. Here are some examples:

Amethyst - manganese and iron (the amount of iron determines the depth of purple)
Smoky quartz – aluminum
Rose quartz – iron and titanium

Can you find 3 green minerals in Exhibit 3?

2 **GEO-EXPLORER**

Mica is flexible and peels in sheets. Two kinds of mica are on display here, biotite and muscovite. Muscovite was named after the city of Moscow, where this transparent mica was once made into windowpanes.

A humble mineral, feldspar is the most common mineral group found in rocks on earth. This mineral is what makes red clays red, like terra cotta.

***Exhibit 4.*** This case contains many yellow minerals that have very different properties. Pyrite is also known as "fool's gold". It resembles real gold, and might fool miners into thinking they had struck it rich. Look for both real and fool's gold in this case. Sulphur is a bright yellow mineral that is associated with volcanoes and can combine with oxygen to make a stinky, rotten egg smell.

## Did you know?

*Minerals are in things you use every day!*

Cosmetics
- Rouge – hematite
- Sparkles in anything – mica

Sand paper
- Roughness – garnet

Colored printing
- Getting the colors to stick – clay

Aluminum cans
- Aluminum – bauxite

Rubber
- Flexibility– sulphur

Matches
- Sparking – sulphur

Milkshakes
- Thickener – kaolinite (clay)

Baby Powder
- Talc

Foot scrub
- Pumice

Drywall
- Gypsum

***Exhibit 5.*** Fluorite contains the element fluorine, which is added to drinking water and toothpaste to strengthen our teeth. Fluorite can come in many different colors.

***Exhibit 6.*** This case contains a number of minerals that may look fuzzy, but if you touched them they would feel prickly like a cactus.

***Exhibit 7.*** Red granite, Wisconsin's State Rock, is composed of three minerals: the red mineral is feldspar, the white is quartz, and the black is biotite mica. Both specimens were quarried near Wausau, Wisconsin. *See Exhibit 3 for examples of quartz and biotite mica.*

***Exhibit 8.*** The clear, cube-shaped mineral in this case is halite and is commonly known as rock salt. This is the same salt that is in your saltshaker at home! Apatite is the mineral that makes up your teeth and bones.

Mountains are built when the outer part of the earth, the crust, crumples and folds because great forces are pushing on either side of a tectonic plate. To make your own mountains, take a piece of newspaper and lay it flat on the floor or a table. Put one hand on each end and push your hands together. Mountains!


### *The Chemistry of Color*

Minerals can vary in color, like you've seen with fluorite that can be purple, blue, green, yellow, colorless, brown, pink, black, and reddish orange. In this case you're looking at carbonate minerals that have some brilliant colors. These colors are due to either impurities in the crystal structure or differences in their chemical formulas.

For example, rhodochrosite has the chemical formula $MnCO_3$ in which manganese (Mn) is causing the mineral's red color. Similarly, with malachite $Cu_2(CO_3)(OH)_2$ and azurite $Cu_3(CO_3)(OH)_2$, the amount of Cu is responsible for the minerals' color.

Rhodochrosite, malachite, and azurite are all examples of a mineral's chemical make-up being responsible for their color. On the other hand, calcite can vary in color because of impurities in the mineral's crystal structure. When calcite is darkish red, iron is the culprit; when it is pink, manganese is to blame.

***Exhibit 9.*** A geode forms when water that is rich in dissolved minerals flows through a cavity in a rock. Minerals form concentric patterns as they fill in the cavity.

Asbestos, lower left, was once widely used to insulate buildings but is now being removed as the fibers can cause lung disease. Tiger-eye forms when asbestos molecules are replaced by quartz.

***Exhibit 10.*** Notice the angel-wing calcite. These crystals were not glued together, but actually grew like this in a cave in Mexico.

***Exhibit 11.*** These two copper nuggets are glacial erratics. Erratics are large rocks and minerals that are carried for long distances by the glaciers. During the last Ice Age, which began two million years ago, glaciers moving across the Lake Superior region, ripped up the copper and dragged it southward. Notice the glacial striations on the back of the larger nugget.

***Exhibit 12.*** Galena, a lead ore, is the Wisconsin State Mineral. Wisconsin owes its nickname, the Badger State, to the lead and zinc miners of the 19th century. The miners were called badgers because they dug shelters in the ground to live in during the winter.

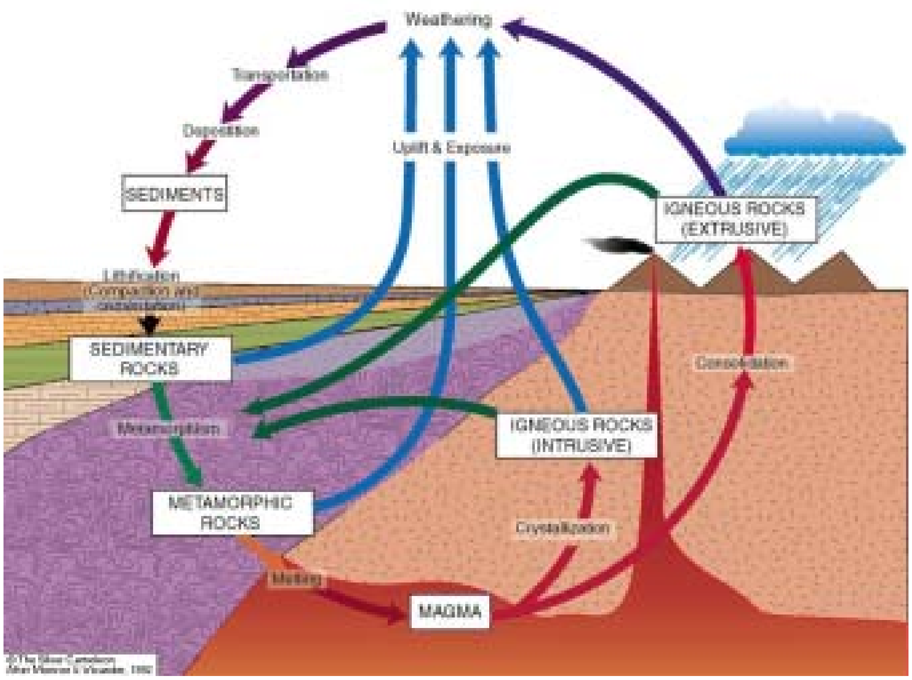
***Exhibit 13.*** This display case contains a gem from our collection.

## Did you know?

*Copper*

The Statue of Liberty is made out of a steel framework and covered with a copper skin that can move independently of the framework in response to changes in temperature or in wind. The total weight of copper used is 31 tons (about *6 elephants* worth of weight). When the statue was first finished, it was shiny copper and over time it has “rusted”, leaving a green crust on it.

***Exhibits 14, 15.*** These cases show the three rock types and examples of where they are formed. Sedimentary rocks are laid down in layers, usually under water. Limestone is a sedimentary rock composed of tiny calcite crystals and frequently contains fossil seashells. This is the rock type that you’ll see around southern Wisconsin, composed of sediments deposited by an inland sea 450 million years ago.




Metamorphic rocks have undergone change from exposure to heat and/or pressure; not enough heat and pressure to *melt* them, but just to deform them. Subduction zones, where one tectonic plate is being pushed under another, are areas of metamorphism. Often these kinds of rocks look as though they’ve been squished.

Igneous rocks begin as hot molten rock, called magma. Plutonic or intrusive rock forms when magma cools slowly underground, allowing time for crystals to grow large. Red Granite, the Wisconsin State rock (*Exhibit 7*), is an example. Volcanic or extensive rock forms when magma is forced out of the ground under great pressure and erupts as lava at the surface. The lava cools quickly, and crystals have little time to grow and are usually quite small. Basalt is a volcanic rock. See the basalt rocks and a vial of Mt. St. Helens volcanic ash.

## THE BLACKLIGHT DISPLAY

*Please read the following before pushing the button.*

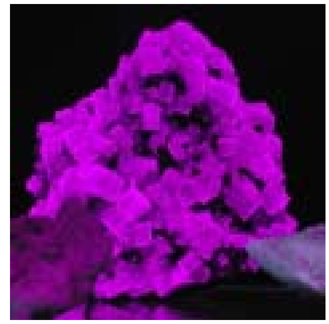


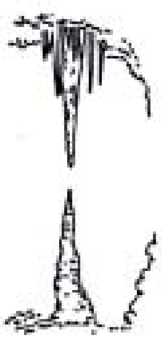
***Exhibit 16.*** As you come into this room, read the sign on the back wall for an explanation of the rocks and minerals on display.

The specimens in this room will glow in a variety of colors and intensities. You may notice that your clothes glow, as the detergent used to wash your clothes may also contain fluorescent materials that are intended to make your "whites whiter" when exposed to sunlight.

The sign to the left of the case indicates which light or combination of lights is turned on. When only the short wave light is on, choose your favorite specimen and watch it as the lights go out. Did it glow in the dark (did it "phosphoresce")?

## THE CAVE

***Exhibit 17.*** Caves are formed when acidic groundwater or underground rivers dissolve out cavities in rock. This cave exhibits features typically found in limestone caves such as the Cave of the Mounds, near Blue Mounds, Wisconsin.



Look up as you walk through this cave. From the ceiling hang soda straw stalactites as well as thicker, more robust stalactites. These form when water containing dissolved limestone drips from the walls and ceiling. As calcium carbonate (limestone) builds up at the tip of the stalactite hanging from the ceiling, directly below, a stalagmite will begin to form on the cave floor. These two may eventually join to form a column.

Look up the crevice on your left for a tree root that has grown down into the cave. Imagine that you are *underground*, and that above you there are layers of rock, soil, and vegetation. As you exit, you will see these layers clearly.

Did you know?

*Calcium in your home!*

Calcium carbonate (dissolved limestone) is in our tap water here in southern Wisconsin. The evidence? It's that white, crusty rind on your showerhead or kitchen sink faucet. Just like the stalactites in the cave forming as water drips from the ceiling, water evaporating from your faucets will leave behind a limey rind.

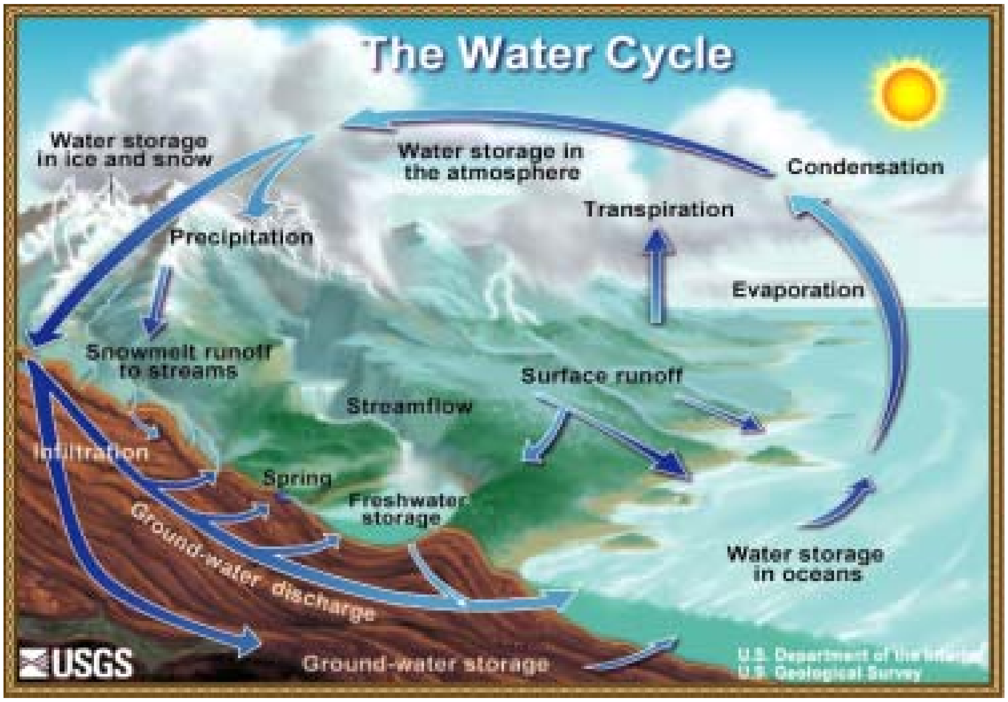
* Water flowing through caves can carve scallops into the cave walls. Can you see any in our cave?

* Dolomite is a magnesium-rich limestone that often contains fossils. Can you find any fossils in our cave?

**GEO-EXPLORER**

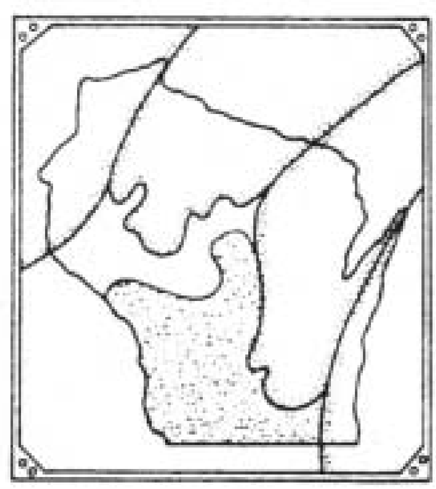
# WISCONSIN GROUNDWATER

***Exhibit 18.*** Did you know that the water that comes out of your faucet really comes from underground? The rocks under our feet have very small spaces in them, called pore spaces, which are filled with water. It has taken thousands of years for that water to accumulate, after falling out of the sky and soaking into the ground.




# GLACIAL WISCONSIN

***Exhibit 19.*** Over the last 2 million years, global climate fluctuations have caused glaciers to form, advance and retreat several times. For example, a thick ice sheet formed in Canada and at its peak stretched all the way to Nebraska. The glaciers did not advance uniformly, and southwestern Wisconsin was missed entirely. This region is known as the Driftless Area and has more relief (steep hills and cliffs) than places where glaciers once were.



Have you ever been to the state capitol or walked up Bascom Hill on campus? Both the capitol building and Bascom Hall sit atop drumlins. These are large, teardrop shaped mounds that form underneath glaciers. Check out other glacial landforms that you may have seen on the post to your right.

# FOSSILS

Fossils can be defined as any evidence of ancient life including bones, shells, molds, casts, tracks, petrified wood, and impression of softer material such as insects, soft-bodied sea animals, and plants. Anything younger than a few thousands years is generally not considered to be a fossil.

***Exhibit 20.*** These large, rounded blocks are fossilized communities of cyanobacteria (formerly referred to as blue-green algae) called stromatolites. As the bacteria grow, calcium carbonate (limey mud) precipitates in layers that you can see if you look carefully. Some of these stromatolites were collected in northern Minnesota and are 2 billion years old while others are from Wisconsin when a shallow sea covered much of the Midwest, about 450 million years ago.

Did you know?

*Stromatolites and our atmosphere...*

If it weren't for these modest-looking fossils (exhibit 20), we likely wouldn't have an atmosphere suitable for many other life forms, including humans. Stromatolites, like plants that we know of today, are photosynthetic and "exhale" oxygen. Billions of years ago, stromatolites were the dominant life form on earth. While they've diminished in abundance, stromatolites still can be found in Sharks Bay, Australia.

***Exhibit 21.*** The "Tower of Time" poster documents the history of life during the past 700 million years. You will find examples of many of these plants and animals as you continue your tour of the museum.

Did you know?

*What do we use coal for? To make electricity!*

To the east of the geology building on Dayton Street is one of the University's coal plants, where electricity is made to power many buildings on campus. Coal is the United State's most common source for electricity. Here is how coal stacks up to other energy sources:

Coal (56%)
Nuclear (24%)
Natural Gas (10%)
Hydroelectric (8%)
Alternative sources (wind, solar) (2%)

It took 10 feet of plant material to turn into one foot of coal!

## PLANT FOSSILS

***Exhibit 22.*** This large painting takes us back 300 million years to the Carboniferous Period, when extensive swamps with a rich vegetation of tree ferns, scale trees, and other ancient plants covered parts of Pennsylvania, Illinois, and other areas in the northern hemisphere. Much of this vegetation has since been buried and turned to coal.

***Exhibit 23.*** Petrified, in Latin, means "turned to stone" and that's what has happened to this tree stump. After the tree was buried, minerals dissolved in groundwater replaced much of the original material but preserved the woody texture. Look at the top surface of the stump. Even the tree rings have been preserved!

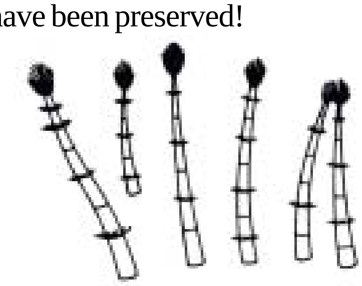


***Exhibit 24.*** This case contains fossilized plants including ferns, sphenopsids (relatives of the modern horsetail plant), lycopsids (scale trees), a cycad, and some polished slabs of petrified wood (the red color is due to iron oxide).

## Did you know?

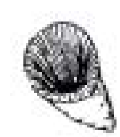
*Amber is fossil tree sap…*

Have you ever gone tree climbing and gotten your hands all sticky? That sticky stuff is tree sap and over time, it, too, can fossilize and turn into amber. You can imagine that all kinds of stuff can get stuck to sap while it's still running down the side of the tree. If you look closely at our amber on display in case 24, you can see bugs and tree bark that were incorporated into the sap before it hardened.

## INVERTEBRATE FOSSILS

***Exhibit 25.*** This limestone slab is a piece of the Cretaceous seafloor (100 million years old) from an area near Austin, Texas. You can see the molds of clam and snail shells on the surface.

***Exhibit 26, 27, 28.*** These three cases display marine invertebrates (animals without backbones) that lived in the sea. The jellyfish, sponges, corals, clams, snails, and cephalopods inhabited the ancient seas long before life had developed on land. Many of them look very similar to their modern day relatives.



These jellyfish fossils (case 26) - as well as many of the fossils in the cases in front of you – were found *in Wisconsin*. What does this mean about Wisconsin in the past? What kind of environment do jellyfish need to live? By looking at the rock that these jellyfish fossils are preserved in, can you tell in what kind of environment they were deposited?

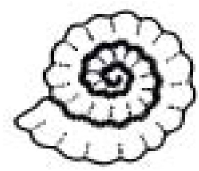
The story of these stranded jellyfish is much like one that you may hear for whales that get stranded on the beach. As the tide washed in and out forming the parallel wavy ripples that you see on the top of this sandstone slab some jellyfish were carried in on the waves. As the water rushed back out to sea, some organisms were left high and dry on the beach. They died, dried out and were quickly covered by more sand. All we have left as proof is the impressions of where their bodies lie. This is because in order to have a body fossil, we need hard body parts, like bones or shells. Think of setting a brick and a marshmallow outside, and watching what happens over the next year. What would last longer?

**GEO - EXPLORER**



***Exhibit 29.*** When fragile fossils are found "in the field", scientists often clear out the area around them, cover the fossil with a layer of tin foil, followed by a thick layer of plaster and burlap. This "jacket" protects the fossil on the long trip out of the field and back to the museum. The room in front of you is where students and volunteers work to clean off and prepare fossils for display. You'll see fossils from dinosaurs, a mososaur, and a bulldog fish later in the museum that were all prepared and reconstructed in this room.

***Exhibit 30.*** The large fossils mounted on the wall are cephalopods. These squid-like marine animals lived in the last section of a long chambered shell. New chambers were added as the animal grew. Inside, a long tube connected all of the chambers and allowed the animal to regulate the air pressure in its shell, which would move it up and down in the water. The straight-shelled forms came first, evolving into species with coiled shells over time. Many cephalopods became extinct along with the dinosaurs, 65 million years ago.



Next time it rains, look outside and try and find fossils of the future. Do you see anything being buried? Look for impressions of leaves or animal footprints (including humans!) in the mud…. those count, too!


## Did you know?

*Superposition*

Say you come home from school on Monday, go to your bedroom, take your sweatshirt off and toss it on the floor before running outside to play. Tuesday you come home and do the same thing, tossing your sweatshirt from today on top of the one from yesterday. Wednesday, Thursday, Friday… same routine. On Friday night, your mom asks you where the sweatshirt you wore on Monday is. You look at the pile of sweatshirts on the floor…

Where is it?

On the bottom of the pile, right?

Why?

Because it was the first one you took off and put on the floor.

This same rule is true when paleontologists find fossils. If there's a pile of fossils, the ones on the bottom are oldest, because they died and were covered up first.

***Exhibit 31.*** Fossils are generally preserved hard parts such as shells, teeth, or bone. Specimens from the Burgess Shale, however, also have their soft-parts preserved, an unusual addition to the fossil record. In order to be this well preserved, the animals must have been deposited in an anoxic, or oxygen-free, environment where they wouldn't be scavenged or decompose. The animals represented here are 505 million years old and date from just after the Cambrian Explosion, which was a major evolutionary event (not an actual explosion) where many new types of organisms appeared in a very short amount of time.

***Exhibit 32.*** *Hesperornis* is a flightless, toothed bird that lived during the Cretaceous Period, at the end of the "Age of Dinosaurs". As you look at this skeleton, compare the front and back limbs. The "wings" of *Hesperornis* were better at steering the bird while swimming underwater (similar to penguins today) than for flying.

***Exhibit 33.*** Soft part preservation, similar to that of the Burgess Shale fossils, occurs in the 400 million years old rock formation near Waukesha, Wisconsin. Compare these fossils to those from the older Burgess Shale.

**Exhibit 34.** Arthropods are animals that have jointed legs. In this display case you can compare extinct arthropods to their modern counterparts.

The beetles in this case were discovered at the La Brea Tar Pits, now a park in Los Angeles, California. During the Ice Age, springs of water bubbled to the surface near a tar pit, and animals lured to the water for a drink had a nasty surprise when they found themselves stuck in the tar. Even fragile insects, like these beetles, were preserved. Other victims included tree sloths, woolly mammoths, and carnivores that came to prey upon the stuck animals, such as condors and saber-toothed cats.

Did you know?

*Wissconsin's State Fossil*

The trilobite *Calymene* (case 34) is Wisconsin's State Fossil. Trilobites lived during the Paleozoic Era, and went extinct 250 million years ago. Their bodies were flexible, allowing them to curl up into a ball when danger threatened.

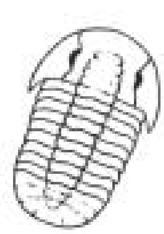


**Exhibit 35.** Bryozoans are colonial aquatic organisms that today are known to grow on the bottom of ships, increasing drag.

Sand dollars, starfish, brittle stars and sea cucumbers all belong to the phylum of echinoderms. These organisms have 5-fold symmetry meaning they grow arms or rays in multiples of five. Can you see this in our fossils?

Many brachiopods have a stalk that sticks out of their shell attaching the organism to the seafloor. They feed by drawing water into their shell and then filtering out food particles.

**Exhibit 36.** Conodonts are enigmatic, extinct animals. The most common fossil remains of conodonts are small, feeding apparatuses but soft-body impressions have been found that show conodonts as worm-like creatures. Conodont jaw shapes have changed through time and are used by scientists to date the rocks that they come from.

**Exhibit 37.** This case displays a community of crinoids named *Uintacrinus*. Crinoids are marine organisms nicknamed "sea lilies" because in life they resemble flowers grow on the sea floor. Most crinoids have a flexible stalk and remain attached to the sea floor. *Uintacrinus*, a crinoid without a stem, would have floated freely in the ocean without a stalk.

## VERTEBRATE FOSSILS

**Exhibit 38.** In Kansas, there are thick layers of chalk that contain many fossils of animals that once swam in a shallow sea that stretched up from the Gulf of Mexico all the way to the Arctic Ocean. In this display case, you can see the remains of a shark skeleton embedded in chalk, complete with its stomach contents.

**Exhibit 39.** The large black teeth at the bottom of the case belonged to *Carcharadon megalodon,* a shark the length of a school bus that could open its mouth 6-7 feet! This shark went extinct 1.6 million years ago. Although shark teeth are often found, a shark's skeleton is rarely preserved as it is made of cartilage, which is softer than bone and decomposes more readily. Compare these shark teeth to those in case 38. Based on their size, which shark was bigger?

***Exhibit 40.*** Modern lungfish are able to survive when the rivers and pools they live in dry up during the droughts. They are able to burrow into mud and make a mucus-lined burrow in which they live until the water returns. Look at the top of this rock slab. Can you see all of the holes? The deep holes are the burrows of lungfish that successfully left their burrows.  Do you see any holes that are shallow and filled with sediment? Some lungfish may have died in their burrows, so the holes are still mostly filled.

***Exhibit 41.*** Reptiles or amphibians? Reptiles first evolved from amphibians during the Carboniferous (Pennsylvanian) Period. These are fossils that have some amphibian and some reptilian characteristics. These animals, therefore, cannot with certainty be classified in either of the two groups.

***Exhibit 42.*** *Captorhinus* is a small reptile from the Permian of Oklahoma. In this exhibit you can see the progression of assembling a fossil. First look at the piece of rock and embedded bones. A student assistant removed the bones from the rock, ending up with a pile like the one in the glass dish. Next the fossil had to be assembled, a difficult three-dimensional puzzle! You can see the final product on display here.

***Exhibit 43.*** When fossils are found, they're often in poor condition and require many hours of restoration work before they can be put on display. These titanothere skulls took several months to complete; the photograph shows one of them partially put back together.

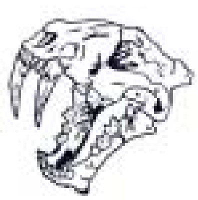


***Exhibit 44.*** This 32 million year old saber-toothed cat was nearly full-grown and would've weighed about 50 pounds. Like humans, cats have two sets of teeth during their lifetime, their milk teeth being replaced by a second set of adult teeth. Look closely for the adult canine teeth that are emerging along the inside of the large milk teeth. If the animal had lived just a few weeks longer, the large canines would've fallen out.

When fossils are first found often it's not by a scientist but by someone else accidentally spotting one weathering out of the ground. After they are uncovered properly by paleontologists, such as the shark skeleton was in case 38, they may not make much sense. What are some reasons the skeleton might be missing pieces or scrambled up?

Look at the fossils next to numbers 5, 6, and 8. Those are pieces of a fish, turtle, and mosasaur that are located near the stomach region of the shark. This is circumstantial evidence of these animals being eaten by the shark before it died. Can you think of better evidence that might be found if we looked closer?

**GEO-EXPLORER**



To the left, you see *Mesohippus*, an adult horse from 32 million years ago. Early horses were not only small, but had 5 toes on each foot, species evolving later only had three, the middle toe eventually becoming the modern hoof. Horses first evolved in North America and migrated across the Bering Strait into Eurasia twice, once 11 million years ago and again 5 million years ago. They later became extinct in North America, but were reintroduced to this continent by the Spaniards in the 1500's.

Can you spot "cousins" of modern day animals in this room? Look for animals that look similar to an elephant, a rhinoceros, and an armadillo.



***Exhibit 45.*** Ichthyosaurs were fish-like marine reptiles swimming in the Mesozoic seas. Like porpoises and dolphins, Ichthyosaurs used their four flippers for steering and balance and their tails for locomotion.

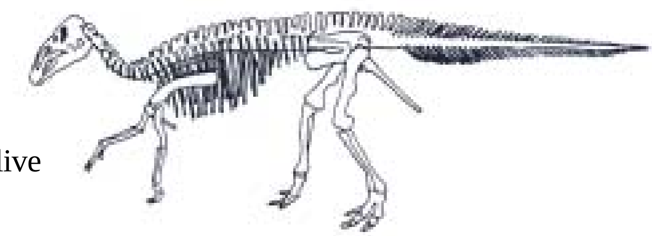


***Exhibit 46.*** This plant-eating duck-billed dinosaur (*Edmontosaurus*) lived during the Late Cretaceous Period (65 million years ago). In addition to its duck-like snout, *Edmontosaurus* may have had webbed feet, enabling it to live in swampy areas. Duckbills gathered at communal nesting grounds and laid their eggs in nests made of mud.

Unlike most reptiles, dinosaurs appear to have cared for their young. Duckbills provided their newly hatched babies with vegetation while still in the nest, and when old enough to travel, the young were likely kept in the center of the herd for protection, much like musk oxen or elephants behave today.

***Exhibit 47.*** The Black Hills Institute of Geological Research in Hill City, South Dakota donated this *Tyrannosaurus rex* skull. This cast is of a *T. rex* named "Stan" and is the best-preserved skull of its kind. "Sue", the *T. rex* on display at the Field Museum in Chicago, is the most complete T. rex ever found, however its skull was crushed and can only be examined by using a cat scan.

***Exhibit 48.*** This *Triceratops* skull is approximately 30% original bone while the rest is reconstructed. Museum field crews from 1996-2001 discovered the original skull pieces in the badlands of Montana.

## Did you know?

### *Real or replica?*

It's very rare that an organism is preserved in the fossil record. Organisms with the best chances of becoming fossils have hard parts (bones or shells) and even then their carcasses must not completely decompose, be scavenged, or (once fossilized) eroded away.

With these kinds of barriers to being preserved, it's not hard to imagine that scientists are lucky to find even *50%* of an organism! The *Edmontosaurus* skeleton (exhibit 46) for example, consists of 500 bones, 350 of which are real bone while 150 are replicas.

Compare the left and right sides of the mastodon skeleton (exhibit 50). As it is facing you, the right side contains mostly real bones while the left side contains more replicas. Can you see the difference?

The *Tyrannosaurus rex* skull (exhibit 47) is a replica, donated to our museum and the reconstructed *Triceratops* skull is about 30% real bone.

***Exhibit 49.*** Hanging from the ceiling above the *Edmontosaurus* is the skeleton model of the flying reptile *Pteranodon* from Cretaceous-age chalk deposits of Kansas. Flying reptiles (pterosaurs) are not dinosaurs! The model is based on bones that the museum staff had previously collected. Rather than using the actual bones, a model was built, because the delicate, hollow bones were crushed and flattened when they were buried, and the surrounding sediment consolidated into solid rock.

***Exhibit 50.*** This mastodon once lived in Wisconsin, near Richland Center, during the Ice Age. It was discovered eroding out of a riverbank by three boys in the late 1800's. A spear point was found with the mastodon bones, and is on display in case 58.

***Exhibit 51.*** The *Dinotherium* is a strange-looking relative of mammoths and mastodons. Paleontologists hypothesize that the tusks protruding from its chin were used to dig up roots for food.

Many of the fossils in this room came from animals that lived at the same time. When paleontologists study fossils, they often ask questions like "who was eating whom?". In this room, you can be the paleontologist. Look for clues as to which were predators (sharp teeth) and which were plant eaters (flatter, grinding teeth).

The Mesozoic (250-65 million years ago), is considered the "Age of the Dinosaurs" but many other animals lived then. Look for dinosaurs *Triceratops* (exhibit 48), *Edmontosaurus* (46), *Tyrannosaurus rex* (47), *Deinonychus* (case 56), and *Pachycephalosaurus* (56). Then look for the mosasaur (exhibit 53), ichthyosaur (45), and *Archaeopteryx* (55).

Our museum has a rich collection of fossils from the badlands of South Dakota, fossils that are from the Oligocene (36 million years ago). In case 44, you can find a saber-tooth cat and the early horse *Mesohippus*. Look to your right to find the large titanothere. Finally, look through case 57 where most of the specimens are from the same time period.

The Ice Age was populated by a "megafauna" – extra large animals that wandered North America. Some examples of these animals are the *Glyptodon* (exhibit 52), mastodon (50), mammoth (case 58), saber-tooth cat (57) and giant beaver (57).



***Exhibit 52.*** *Glyptodon,* an ancestor to modern-day armadillos, had a large, armored shell and a spiked tail to protect it from predators.

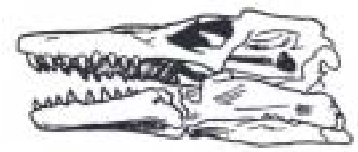


***Exhibit 53.*** Eighty-three million years ago, a marine reptile known as a mosasaur swam in the shallow sea that covered parts of North America. Once the mosasaur died, its carcass settled to the sea floor where it was devoured by scavengers. Bite marks on the skeleton accompanied by scattered shark teeth bear witness to this feast. The head may have been dragged off, as it was missing when scientists found the skeleton. Limey mud settled over the bones and covered the bones, allowing them to fossilize. The sea retreated and the mosasaur skeleton was left buried under many feet of rock. Today, a prairie covers this area.

In 1988, scientists Joseph Skulan and Patrick Druckenmiller led a group of volunteers to Kansas where they removed 85 tons of chalk while excavating this mosasaur skeleton. Another mosasaur skeleton that was discovered nearby provided the missing head for our specimen. The injured ribs were diagnosed and the arthritic back right flipper was examined by an orthopedic veterinary surgeon.

***Exhibit 54.*** Dinosaur eggs are a rare find; usually they are crushed and broken after the baby dinos hatch. Here you can see a small *Protoceratops* egg that was discovered in Mongolia, and an estimated replica of what an *Apatosaurus* egg would have looked like. No *Apatosaurus* eggs have ever been found, and some scientists speculate that the large dinosaurs did not lay eggs, but rather gave birth to live young.

***Exhibit 55.*** *Archaeopteryx* was warm-blooded, raven-sized, and able to fly. *Archaeopteryx* is considered to be a link between reptiles and birds, for it had bird-like features such as feathers and a breastbone, but a bony tail and well-developed teeth like a reptile. In fact, prior to the discovery of feathers on a certain specimen, *Archaeopteryx* was misidentified as a coelurosaur dinosaur.

Only eight specimens of *Archaeopteryx* have been found so far, all from the Solnhofen Limestone deposits in Bavaria, Germany. The limestone, once used to make lithographic plates, was quarried with great care, and the delicate fossils were preserved virtually intact. Our specimen is a cast of the most complete specimen that is housed in the Museum of Natural History in Berlin, Germany.

When scientists find a new kind of fossil, they have earned the right to give it a new, scientific name. While the names they assign may sound funny to us, they mean something in a different language. Generally, a scientist will name a fossil based on either what it looks like, the place where it was discovered, or for a significant person.

Here are some examples of the meaning behind the names of some of the fossils on display in our museum.

| | |
|---|---|
| bi- = two | cepha- = head |
| tri- = three | -dactyl = finger, toe |
| cera- = horned | pter- = wing |
| -tops = face | pachy- = thick |
| -pod = foot | archaeo- = ancient |
| echino- = prickly | -therium = mammal |
| -derm = skin | dino- = terrible |
| brachio- = arm | -saur = lizard |
| pseudo- = false | -don = tooth |

What does *Pachycephalosaurus* mean? Can you find one in our museum? Does the name make sense?

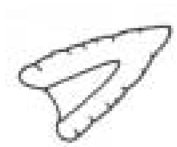
**GEO-EXPLORER**

***Exhibit 56.*** Find the small-scale model of the mosasaur and compare this marine reptile to the freshwater *Mesosaurus* found in Permian-aged rocks approximately 250 million years old. Specimens of *Mesosaurus* have been found in southern Africa and Brazil, evidence that these two continents were once connected, forming the southern part of Pangea called Gondwana.

Now look for the dinosaur tracks in this display case. More than 65 million years ago, a three-toed dinosaur left footprints in mud that was later buried and turned to stone.

***Exhibit 57.*** In the middle of this display case is a replica of a skull from a large saber-toothed cat that lived until around 4,000 years ago. Compare this skull to the one in exhibit 44.

***Exhibit 58.*** This case contains the small spear point discovered near the Boaz mastodon (exhibit 50). Spear points of this kind date back 10,500 years, and provide evidence that people were living in Wisconsin at the end of the Ice Age.



While soft parts usually decompose and aren't represented in the fossil record, mammoth hair, skin and marrow have been defrosted from the Siberian tundra.

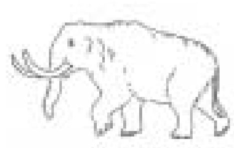
***Exhibit 59.*** *Archaeotherium* is a giant pig-like animal that lived 35 million years ago and would have stood 3 feet tall at the shoulder. In this specimen, you can see tooth marks in the backbone, indicating that after it died, another animal was chewing on some of the animal's backbone.

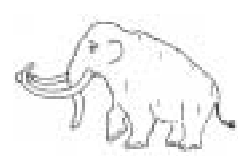
***Exhibit 60.*** This mural is a depiction of what the area around Madison may have looked like 12,000 years ago. You can see a woolly mammoth, a relative of the mastodons and of the modern elephants, grazing on grasses. Glaciers didn't advance over southwestern Wisconsin, giving it the name the Driftless Area.

***Exhibit 61.*** Sometimes the virtue of certain stones is aesthetic. This cephalopod slab is a prime example of decorative building stone that you may see in a hotel lobby or our state capitol building.

## Did you know?

*Mastodon* *vs.* *Mammoth*





| | Mastodon | Mammoth |
|---|---|---|
| First appearance: | 20-30 million years ago | 2-3 million years ago |
| Teeth: | rounded for swamp veggies | blocky for grasses |
| Backs: | flat from hips to shoulders | sloped from hips to shoulders |
| Tusks: | 8.5 feet long | 11.5 feet long |

In exhibit 58 you can compare the teeth of the mastodon and mammoth.

***Exhibit 62.*** Scientists and students in this museum go out west each summer in search of new fossils for their research and our museum. The photographs show the landscape in which they work and camp for weeks. The fossils they bring back are what they work on cleaning and examining through the winter months - remember looking through the window into the prep lab?

## EXTRATERRESTRIAL GEOLOGY

***Exibit 63.***
The Canyon Diablo meteorite fell to earth between 25,000 and 50,000 years ago near where Holbrook, Arizona is today. The crater is 3/4 mi wide and 640 ft deep. This hole was created by a meteorite that was originally about the size of a school bus! Pieces recovered are made primarily of iron and nickel.

***Exhibit 64.*** These plaster replicas are of moon rocks collected during the six Apollo missions between 1969 and 1972. Most of the actual specimens are kept safely in nitrogen-filled vaults at the Johnson Space Center in Houston.

Moon rocks are quite similar to rocks found on earth (note the breccia, basalt, and gabbro). The earth and the moon both have long histories of meteorite bombardment, but erosion has eliminated most of the evidence on earth. The moon, devoid of liquid water or an atmosphere, is not subject to erosion so that ancient craters are still preserved.

***Exibit 65.***
Most meteorites are thought to originate in the asteroid belt, an area between Mars and Jupiter filled with dust and rocky debris. Jupiter's gravitational field is so strong that this material never condensed into a planet. Some fragments of these asteroids escape their orbit and if their path brings them close to earth they are pulled in by the earth's gravitational field. These are called meteoroids. The ones that hit the ground on earth are then called meteorites, and ones that burn up in the earth's atmosphere due to frictional heat are called meteors. You may know meteors as "shooting stars" or bright streaks in the night sky.

***Exhibit 66.*** Marcasite is an iron sulfide, a variety of fool's gold. It was used in fashionable jewelry in the 1920's and 30's and again in the 1990's. It's a mineral common to the Upper Mississippi Valley. The variety shown here is called cockscomb marcasite.

*You have reached the end of your tour. We hope you enjoyed your visit!*

*Please come again!*

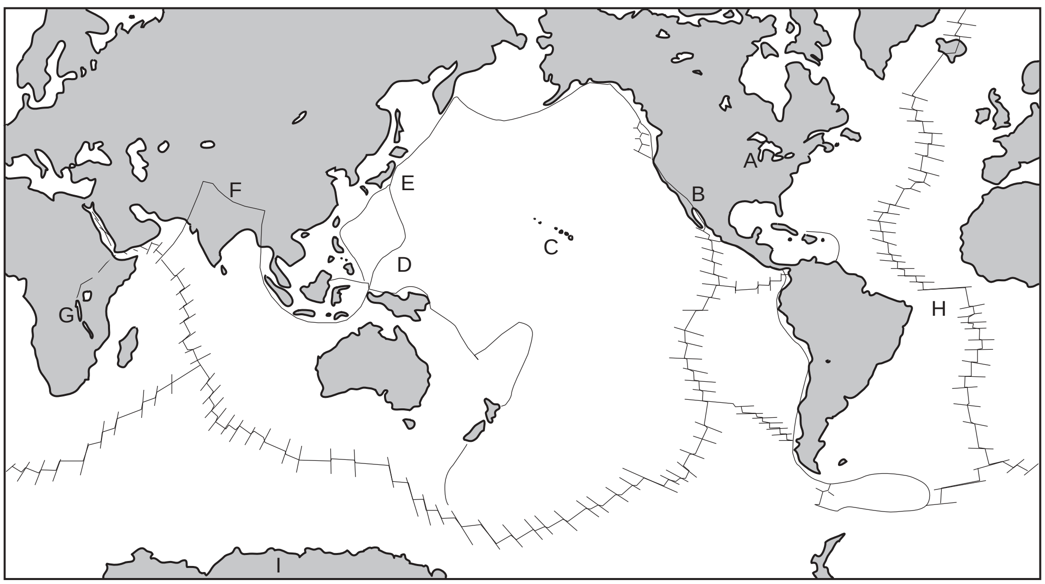
# ANSWER KEY

***GeoExplorer 1***

This question has two answers! The globe is spinning faster than the earth because the globe rotates once every 3.5 minutes while the earth rotates only once every 24 hours. However, the *surface* of the earth is spinning faster than the *surface* of the globe. At the equator, the surface of the earth is traveling at over 1,000 miles per hour, whereas the surface of the globe is moving about 1 mile per hour.

The globe is tilted 23° on its axis. As the earth travels around the sun, this tilt causes the sun's rays to strike the northern hemisphere more directly during the summer, and southern hemisphere more directly during the winter.

The earth is spinning counter-clockwise when viewed from the North Pole.




(Letters correspond to the locations on the map.)

***GeoExplorer 2***

Green minerals in case 3: amazonite, andradite, dioptase, epidote, olivine, and some tourmaline.

***GeoExplorer 3***

There are scallops on the wall both to your left and directly ahead as you enter the cave. The cave contains brachiopods, cephalopods, snails and clams.

***GeoExplorer 4***

Wisconsin must have hosted an ocean long ago because jellyfish need water to live in. The ripplemarks in the sand suggest that these jellyfish were deposited on a beach.

The brick will last longer outside because it is more resistant to erosion than the marshmallow.

***GeoExplorer 5***

The bones could have been scrambled up by: scavenging by other animals; waves moving the body parts around; or selective preservation.

Better evidence that the turtle, fish, and mosasaur fossils came from the shark's belly might be bite marks that match the shark teeth and acid etching from the shark's stomach acid.

***GeoExplorer 6***

Elephant – Mastodon (50), mammoth (58), *Dinotherium* (51)
Rhinoceros – Titanothere (43)
Armadillo – *Glyptodon* (52)

***GeoExplorer 7***

Mesozoic
Predators: *Tyrannosaurus rex* (47), *Deinonychus* (56)
Prey: *Triceratops* (48), *Edmontosaurus* (46), *Pachycephalosaurus* (56)

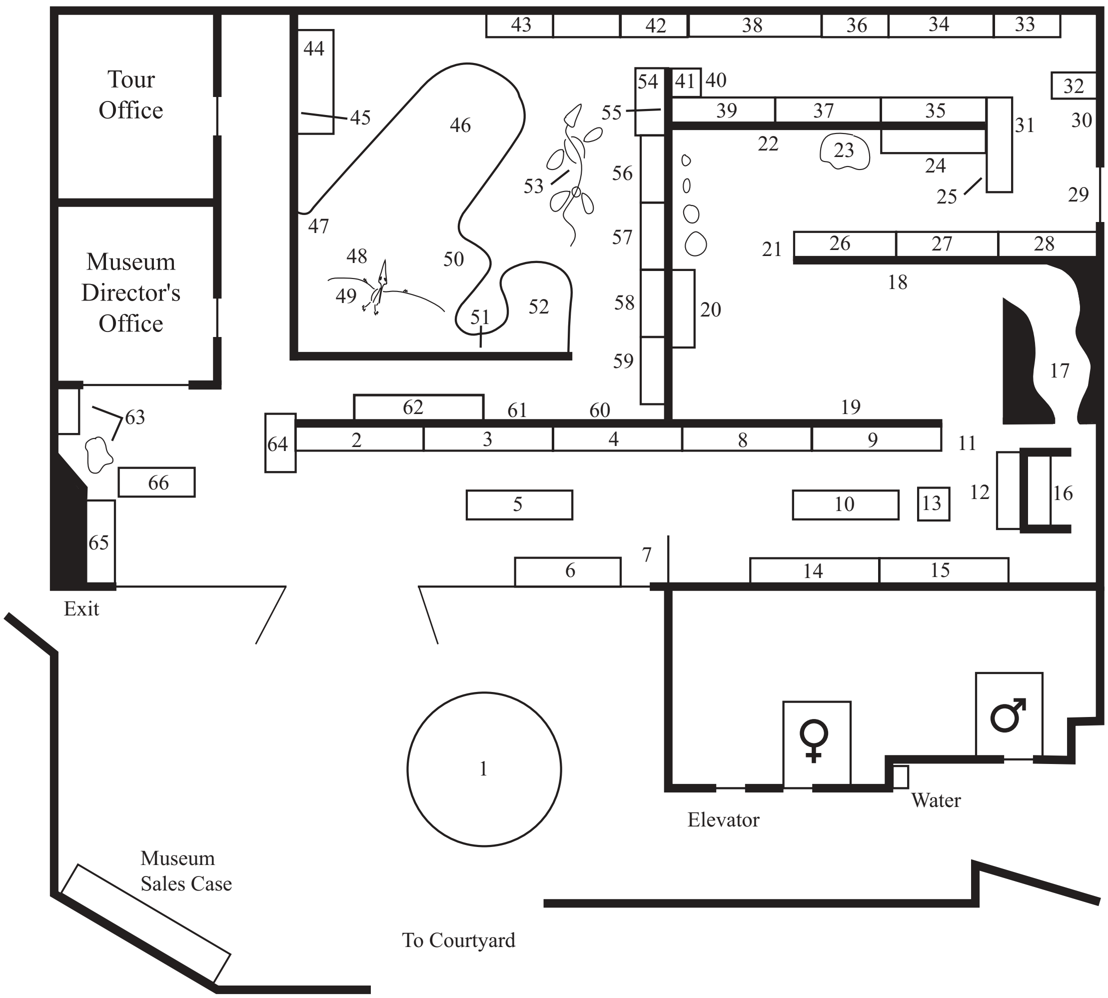
Oligocene
Predators: Saber-tooth cat (44)
Prey: *Mesohippus* (44), Titanothere (43)

Ice Age
Predators: Saber-tooth cat (57)
Prey: *Glyptodon* (52), Mastodon (50), Mammoth (58), Giant Beaver (57)

***GeoExplorer 8***

"pachy" = thick
"cepha" = headed = pachycephalosaur!
"saur" = lizard

# MUSEUM MAP

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