



SEEING THE UNSEEN

INTERPRETING GEOLOGICAL TIME



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Above: A hands-on activity or a “wow!” moment can make any program more meaningful to guests. Here, water poured on the limestone makes the Devonian corals more visible.

The unseen is hidden. It’s usually associated with something tangible. It can be microscopic, tucked away in a hollow tree, or nocturnal. But there is one thing that is unseen yet is all around us—the fourth dimension, time.

Our world is shaped by what was. And while historical sites are experienced in interpreting what was, much of what we see at historical sites is recent history. Of course, *recent* means different things to different people. Abraham Lincoln’s life and legacy are recent. The Roman coliseum is recent. From a geologist’s perspective, the Great Pyramids of Giza are recent.

The landscape is recent: It is now. But it’s also a reflection of what was. Interpreting mountains, rivers, and

bedrock requires us to look deeper, back in time. Not too long ago, a farm was a forest. A quiet oxbow lake was a flowing river. If you are in the Ouachitas of Arkansas and Oklahoma, a big hill might have been a towering mountain range. The world we know is continuously changing.

The story of geological time can be complex. Each layer of rock has its own story. Things happen in sequence and sometimes there are big gaps. The interpreter must prioritize what story is to be told. Usually the “big picture” is the primary story—think Grand Canyon or Yosemite Valley. Sometimes it isn’t. It also conflicts with some visitors’ beliefs. Religion versus science is the occasional source of discord.

At the Falls of the Ohio State Park (named for the Ohio River, not the state), we have several geological stories. Why is it called the Falls of the Ohio when there aren’t any waterfalls of significance? Why are the rapids here and not somewhere else? Those questions are answered, but are not the big story.

The state park was established to interpret a Middle Devonian-age marine fossil bed. It has exposures of the densest deposits of ancient corals and sponges found just about anywhere. And there’s the rub. We have fossil beds that are 390 million years old. But how can you interpret something that old to the non-geologist park visitor in a way that is meaningful?

The History and Use of Geological Time

Geological time is often called “deep time” because it recalls an age before human existence. Examples of reckoning this scale to the average person are common using calendars and clocks—tools of timekeeping that a child can understand. We know January comes before June. Most people don’t know that Cambrian comes before Cretaceous.

Scientists have used different methods to figure out the Earth’s story. Astronomy had the first leap in understanding. The movement of the stars, moon, and planets followed mathematical calculations. Nicholas Copernicus was the first to use math to determine that Earth orbited the Sun and not vice versa. *De Revolutionibus orbium coelestium* was so revolutionary—and against church beliefs—it wasn’t published while he lived, but immediately after his death in 1543. Observational evidence awaited Galileo’s observations of Jupiter’s moons in 1610.

Geology’s “Aha!” moment took longer to achieve because deep time was in the realm of theologians, not scientists. Nicolas Steno is one of the “fathers of geology.” In 1669, he accurately surmised that sedimentary rock was formed in horizontal layers and that inclined, or tilted, layers

were changed at a later time. At the Falls of the Ohio, rock layers are nearly horizontal. A slight dip in the rocks from the Cincinnati Arch means the Devonian Limestone is only exposed at the Falls and not elsewhere in the Ohio River.

In 1760, Giovanni Arduino created the first classification for rocks. “Primary” was crystalline rock with metallic ores. “Secondary” was hard stratified rock without metals that may contain fossils. “Tertiary” was soft sediment, stratified with shells and volcanic rocks. This is hardly accurate, but was an important first step. The term *tertiary* was modified to mean a recent geological time period, which happens to be dominated by soft sedimentary rocks. Paleogene and Neogene are now preferred as a replacement for “Tertiary Period.” We talk about the difference in the formation of limestone from other area rocks.

Scottish naturalist James Hutton is considered one of the fathers of geological time because he introduced the concept of uniformitarianism in 1785. This implies that natural processes, such as uplift and erosion, shape the face of the Earth continuously. He had no concept of geological time, but theorized that the same processes go back to Earth’s early history. We incorporate his concept by discussing how erosion shapes what we see.

In 1775, Abraham Gottlob Werner, one of Europe’s most influential geologist educators, promoted the religiously influenced theory of Neptunism (think Noah’s flood). Better known as catastrophism, it still haunts geology today. Adding to

Fossils provide evidence that extinction is common throughout geological history. French Zoologist Georges Cuvier published irrefutable evidence in 1812.



the confusion is the recurring high water we suffer through each year. It has no bearing on the origin of the fossil beds which were formed under conditions comparable to the seas around Indonesia.

William Smith, the 19th-century English engineer and surveyor, observed the same fossils in rock layers that were geographically distant. He discovered that the sequence of rock layers could be mapped relative to one another by their fossils and published the first aerial geological in 1815. We explain that our fossil beds can be traced about a thousand miles northeast of the park because the same or similar fossils are found over a wide area. In fact, evidence that North Africa and North America were very close is because of the fossils.

Scottish geologist Charles Lyell latched on to Hutton's uniformitarianism because it matched his observations of English geology. His *Principles of Geology*, published between 1830 and 1833, established the tone for the understanding of geological processes that exist today. Charles Darwin, a good friend of Lyell, carried the first volume of *Principles* on the *Beagle*. He saw first-hand evidence described in that book. It helped him understand the importance of time in changes of life over time, leading him to the theory of evolution.

Understanding the changes in fossils over time made a leap forward when French zoologist Georges

Cuvier studied the soft sedimentary rocks around Paris. He observed that the anatomy of vertebrate fossils closest to the surface more closely resembled modern animals. The lower (older) sediments contained animals that were more unfamiliar. In 1812 Cuvier showed conclusively that many vertebrates had no known counterparts today. Extinction happened.

We take extinction as fact. It is the heart of conservation efforts. But as a concept, it is scarcely more than 200 years old! All the fossils at the Falls of the Ohio are extinct—and coral classes rugose and tabulate disappeared from Earth 250 million years ago. The clams in the Ohio River are distant descendants of bivalves in the Devonian. For the six-year-old dinosaur expert, they won't have a strong grasp of geological time, but they know Jurassic Allosaurus lived before Cretaceous *Tyannosaurus rex*!

Interpreting Geological Time to Visitors

Unseen to interpreters is the personal history of the visitor. Unless their clothes proclaim their beliefs (as they occasionally do), one doesn't need to modify how the story is told (for group tours, not public programs). We have found that those who accept science to understand our place in the world, accept concepts of deep time, slow geological processes like deposition and erosion and biological evolution. If they don't, mentioning years in deep time may lead to a

religion-versus-science conversation.

With the park's proximity to the Creation Museum and Ark Encounter, we get a lot of visitors and groups who don't believe in deep time. For those groups, we leave the years off in oral presentations. We can say "390 million years old" or "Middle Devonian." For our interpretive story, either works; but the orientation theater and exhibit gallery are science-based and use numbers.

When incorporating geological time into site interpretation, tell one story at a time. Sometimes that's in chronological order. Sometimes it's in reverse order. For one of our fossil bed discovery hikes, we describe the history as follows: 1) How the Falls developed (at the end of the Ice Age roughly 10 thousand years ago); 2) The origin of the Ohio River when the first glaciers advanced (2 to 1.8 million years ago); and 3) The tropical marine fossil beds (390 million years ago).

Our method is to discuss the origin of the Falls and the Ohio River at the beginning of the hike, while on the deck, where the river dominates the scenery. The age of the fossil beds are introduced when we reach that destination (about 100 footsteps). Sometimes we provide years, sometimes (when we have fundamentalist religious groups) we give geological times (Pleistocene or Ice Age, Devonian).

Geological time interpretation is easier when there are fossils or horizontal sedimentary rock layers. It is more subtle when the landscape is covered with vegetation, partially submerged, or consists of complex mountains. With research and practiced interpretive skills, the unseen can be revealed to inspire.

ABOUT THE AUTHOR

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