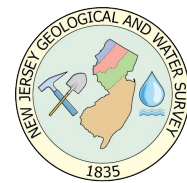




Dinosaur Tracks in New Jersey!

Middle School



2020 NJSLS Science Standards Referred

MS-LS4-1: Analyzing and Interpreting Data

MS-LS4-2: Constructing Explanations and Designing Solutions

MS-ESS1-4: Constructing Explanations and Designing Solutions

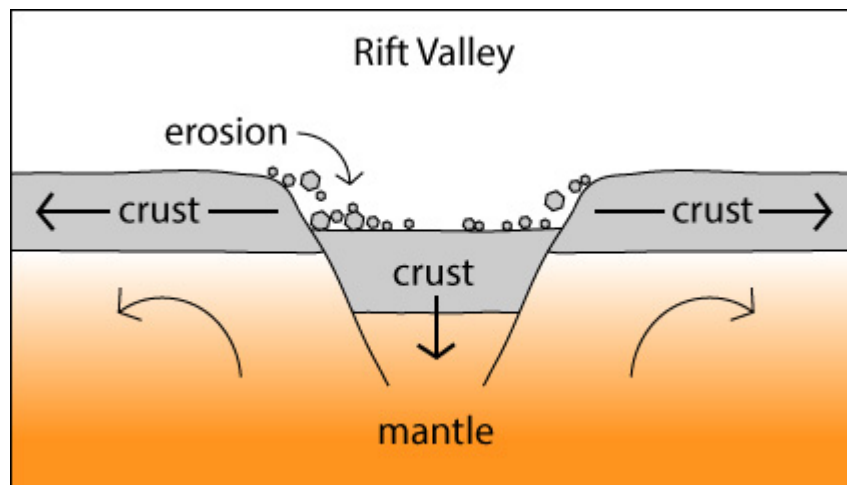
MS-ESS2-3: Analyzing and Interpreting Data

A long time ago – about 200 million years ago, actually! – a dinosaur walked in soft mud and left footprints behind in northern New Jersey. The footprints lasted for millions of years. They were discovered in 2010, which was *not* exceedingly long ago!

- How could these dinosaur tracks last so long?
- What dinosaur made them?
- How were the tracks found?
- How do we know how old they are?

How did the rock form and then survive?

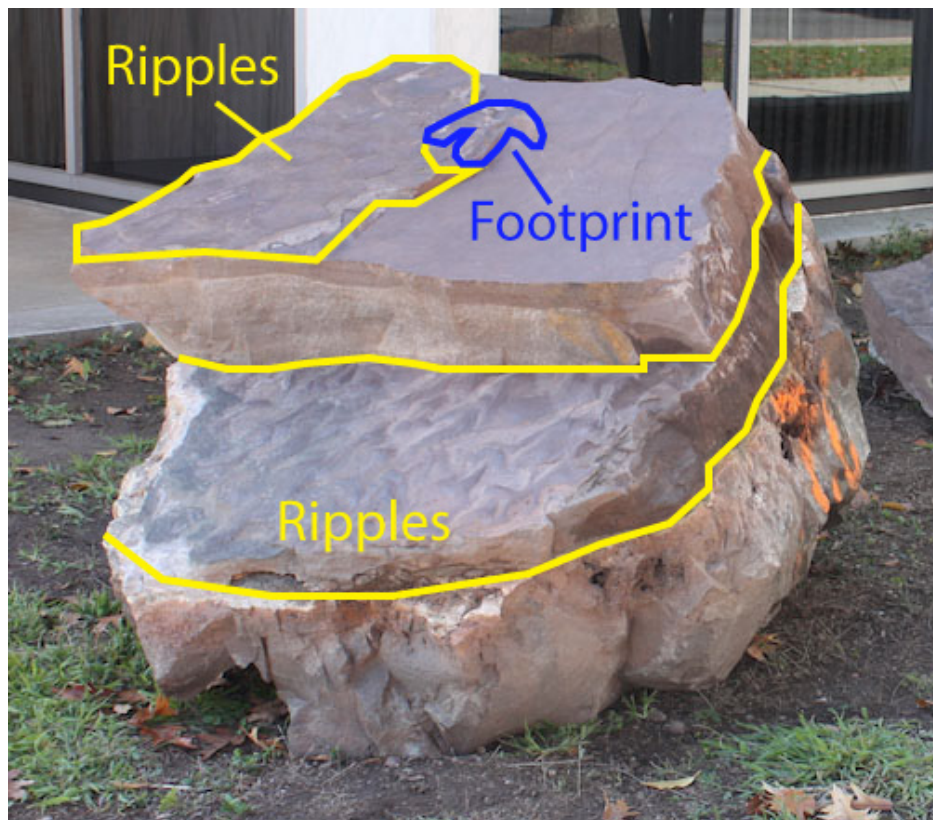
If you have learned about Pangaea – the giant continent that existed on Earth an exceptionally long time ago – then you know that Pangaea was moving and changing for millions of years. When Pangaea tore apart, separate continents were formed. Africa and North America are an example of land that was pulled apart. A “rift valley” formed at the tear. A **rift valley** is a zone where tears occur in the Earth’s crust and upper mantle and where the land in the torn area drops (image below).



The rift valley formed in what is now northern New Jersey. Stone above the rift was broken down by erosion and settled in the rift valley. Over time, layer upon layer was built up. Sometimes, streams flowed over these layers and left behind muddy, soft clay with sand that dried and got wet over and over in cycles. Once, when the clay was wet, water currents left ripples in the clay (image below).



One day, a dinosaur took a walk in the muddy clay in the rift valley! Both the ripples and the dinosaur tracks dried on the surface. Additional clay and some sand washed into the footprints and ripples and filled them in. The sediment, under lots of pressure, formed into thick, hard rock in a process that took millions of years. The ripples and the footprint were preserved in this hardened rock. You can see layers of rock, ripples, and the footprint in the image below.



Then a big geological event took place. Lava flowed across the land, covering the rock with the dinosaur footprints – but the prints were protected from the lava because of so many layers of rock. But *another* major geological event happened! This time, the land was pushed up. This included the rock with the dinosaur footprint, which was buried under an amazing 5000 feet of rock. Somehow it survived all these events! Finally, for millions more years, the rock was eroded to the point where the dinosaur footprint had made it to the land surface.

Who found the rock?

Construction was being done on the very place where the dinosaur prints were made. The rock with the footprint splits open and a workman saw it before it could have been destroyed! Scientists were called in to save it. Now the New Jersey State Museum owns the rock with the footprint. It is outside the front of the museum for everyone to see (image below). It is quite large. You can go there to see it yourself!



There is one special thing to note about this rock – it is upside-down. The footprint is on the bottom of the rock, but it is displayed upside-down so we can view it. The footprint we see is the depression (hole) that the dinosaur's foot made. The rock layer is made of the sand and mud that filled in the footprint.

What dinosaur made the tracks?

We are not sure what dinosaur left its tracks in the mud. All we have is a print. Fossil footprints are known as *ichnofossils* (trace fossils) because there is only a trace of the dinosaur's presence -- no bones or other body parts are there to help us figure out what the dinosaur looked like.

Scientists have guessed that the dinosaur was like an *Anchisaurus*, possibly a *Grallator*, or another unknown dinosaur that left footprints called *Eubrontes*. Our mystery dinosaur may have been about human size or larger, bipedal (two-footed), and carnivorous (meat-eating). Below are images of an *Anchisaurus* and two *Eubrontes* tracks.



There was also a smaller footprint on the rock from the northern New Jersey construction site. We do not know if the dinosaur paused and pressed its smaller front foot into the mud, if it was traveling with a young dinosaur of the same kind, or if a different dinosaur came through the mud and left a print, too!

How old are the footprints?

Scientists can learn the age of rocks from laboratory tests. *Radiometric dating* is a method that uses radioactive material in the rock to show about how old the rock is. The radioactive material in the rock that surrounds the dinosaur footprint was tested.

Below is a closeup of the footprint. Remember, the rock is upside-down. The rock below the footprint – the rippled area on the left – is *more than* 200 million years old. The rock above the footprint – the smoother area on the right – is *less than* 200 million years old. That tells us that the print is somewhere in between -- *about* 200 million years old. That is the Triassic period in geologic time, which comes before the Jurassic.



We can also get a basic idea about the age and type of the dinosaur and its footprints by comparing the tracks to other footprints and fossils. If we already know the age of similar rocks, tracks, or dinosaur bones (from a dinosaur that we know made the tracks), then we can use those items to compare to the new tracks. Then scientists can say whether the dinosaur is like or is *not* like the ones we already know.

Why was the dinosaur there, anyway?

It is anyone's guess why the dinosaur was in a muddy spot in the rift valley. It simply may have been going from one place to another, or perhaps it was running from a predator. There is not enough information for us to know if it was walking or running. There may have been a stream, lake, or other body of water in the valley. Plants would have grown in the moist earth. Dinosaurs may have gone to the rift valley to drink and eat. Carnivores would also find a meal – other dinosaurs! Whatever the reason, this dinosaur had no idea it would leave us an incredibly special piece of history.

Questions

1. What formed in northern New Jersey due to North America and Africa separating?
2. Under how many feet of rock were the dinosaur footprints buried and how did they get covered by so much sediment?
3. Do you think it was helpful for scientists to compare the *Eubrontes* tracks to the footprint in the rock from the construction site? Why or why not? What method can be used to get a more precise age of the rock?
4. Assume that this dinosaur went in the rift valley for food. Explain what kind of food it was probably looking for, and how you know.
5. Take a bright pencil or marker and outline the footprint in the last image. Do you think it could belong to?

Answers

1. Rift valleys formed due to North America and Africa pulling apart.
2. The dinosaur footprints were buried under about 5000 feet of rock. The prints were covered by sediment that fell into the rift valley by erosion, and streams brought sand and clay over the area. Lava also created more layers. With pressure and millions of years, it became rock.
3. Yes, it was helpful to compare the different tracks. Because they look similar, *Eubrontes* helped scientists say about how old the prints are, and they helped show that the dinosaur was probably bipedal, small, and a meat-eater. Radiometric dating can be used
4. The dinosaur may have been looking for meat because we think this dinosaur was a carnivore. Its tracks look like those of other small meat-eating dinosaurs that we know about.

Select material taken from “What's in a Rock? A Dinosaur Track from New Jersey at the State Museum in Trenton”, New Jersey Geological Survey Information Circular, 2017.

Anchisaurus image by Nobu Tamura (<http://spinops.blogspot.com>) - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=19459098>

Thanks to David Parris and Dana Ehret of the New Jersey State Museum for supplying images of the rock and dinosaur tracks.

Below you will find images from another fossil site in New Jersey that contain fossils of the same age as the fossil in the activity above. These fossils come from an area known as the “Red Beds” due to the reddish-brown rocks. Scientists refer to these rocks as the Newark Supergroup Formation. This formation extends from North Carolina to Nova Scotia and is named for the city of Newark, New Jersey.



Ripple marks (Ramsey, NJ)



Grallator print (Ramsey, NJ)



Baby *Grallator* prints
(Ramsey, NJ)



Tail drag - negative imprint from a *Grallator*
Note a portion of the footprint to the upper left
(Ramsey, NJ)

Not all the interesting things found at this location were dinosaurs, some were not even living things.



The small round depressions on this rock were not made by animals but are the result of something quite common. Can you guess what caused these to form?

If you said, "Someone playing with marbles." You would be wrong.

If you said. "Raindrops." You are correct.

A good paleontologist can tell from this single sample that rain fell 190 million years ago at this spot on a Tuesday!

Just kidding, they can't be sure of the year.

The above fossils were collected and photographed by
Marc Rogoff, Environmental Education Specialist,
New Jersey Department of Environmental Protection.