GEOLOGIC TIMEWALK - CENOZOIC
Professor: Teresa Greely, Ph.D

[BANG] [MUSIC PLAYING]

Today we'll be taking a geologic walk throughout earth's history. If we were going to go all the way to the Big Bang, we would have to walk all the way to the Skyway Bridge. We believe the big bang actually occurred 13.77 billion years ago and about 4.6 billion years-- our solar system actually formed around the sun.

We're going to start here in the Paleozoic. We will walk down the seawall from the old Dali Museum towards the waterfront. As we jump into earth's past and walk towards the present, we will witness the different transformations of the oceans, continents, and atmosphere as well as the dominant creatures of each epic. The walk will focus on the Paleozoic, Mesozoic, and Cenozoic eras. The demise of the dinosaurs and other extinction events will be covered to illustrate the rapid termination of life which took millennia to evolve.

The earth and the moon formed roughly 4.6 billion years ago. They were originally dust and a bunch of different kind of material that orbited our sun. And this material coalesced to form early proto-planets. So Theia collided with the earth and the earth kind of reorganized itself and coalesced. It got a little bit bigger from this event. But what was really important was all that ash and material that was in the gravitational field of the earth this eventually coalesced to form our moon.

So the impact of Theia on earth not only gave earth its characteristic tilt. But it also gave us our moon. At this time, the earth was spinning extremely fast. Days were only about six hours long. And the moon was only about 14,000 miles away. Now the moon is almost a quarter of a million miles away.

So after this extreme event, the next important event that happened was the formation of the earth's oceans. Scientists aren't exactly sure if the water was are you present on earth or if it was brought from asteroids or comets or other extraterrestrial bodies in the solar system. But we do know that eventually oceans developed and slowly cooled the outer surface of the earth.

This eventually began the process of plate tectonics. Throughout the geologic time walk, we will discuss the various positions of the continents, earth's atmosphere conditions, and also the evolution of life. Another important note to make is roughly 3.2 billion years ago we start seeing primitive bacteria.

We're not exactly sure where life formed on earth. We know it was in the oceans. But we don't know if it began near hydrothermal vents, if it was brought by asteroids or comets, or if it was just kind of began due to the extreme conditions on earth at the time due to the high heat, the gases present, and also lightning. But we do know that earth began-- life began. And some of the very early bacteria that we see resemble cyanobacteria.

And this is a super-important because they are these incredible organisms that somehow managed to harvest the sun's energy and produce glucose. This is a process known as photosynthesis. And this is extremely important because a very important gas results as a byproduct of this reaction. And that's oxygen.

So over a billion or a billion and a half years, oxygen levels increase in the oceans. And we actually see banded iron formations. This is a key piece of evidence that scientists have found to signify that oxygen levels are increasing in the earth's oceans. We will segue into snowball earth and then begin to talk about the Paleozoic era at our next stop.

[MUSIC PLAYING]

OK, so we've reached our second stop on the geologic time walk. Just before the Paleozoic era. And right now is a period known as snowball earth, a time almost all liquid water on earth was actually trapped in glaciers-- a glacier that surround almost the entire earth. Eventually, CO_2 levels increased due to volcanic activity. And this glacier slowly retreats back towards the poles.

And where you may not expect to find life, we actually revisit the earth's oceans. And we see evidence of very primitive plants and also jelly fish roughly 600 million years ago. And this is right before the Cambrian explosion. It's a time where oxygen levels have increased and organisms somehow evolve a way to precipitate calcite, calcium phosphate, and also silica.

Organisms that we may see inhabiting the earth's oceans include sponges, worms, cephalopods, and trilobites. This is really important because the minerals that they precipitate are actually well-preserved in the geologic record. And this is just marked by an abundance of fossils. Whereas before, it's really hard to preserve an organisms such as a jelly fish due to the low minerals present in the organism.

So roughly 450 million years ago, we see an organism called Pikaia. And it's actually one of the very first chordate animals, potentially an ancestor of ourselves. We see jawless fish closely resembling the hagfish and lampreys that we see today. These fish-- they're very heavily-armored fish typically associated with benthic environments-- not the mobile, quick, free-swimming fish that we see today.

So the interior of the earth actually contains liquid iron. And it's moving around the interior of our planet. And it produces a magnetic field. And what is so important about this magnetic field is it allows earth to have an atmosphere. Oxygen building up in the oceans, slowly out gases into our atmosphere. And it's not blown away by the intense solar wind of our sun because of this magnetic field.

The oxygen reacts in the atmosphere with sunlight to actually produce ozone. And ozone is extremely important because it allows life to slowly migrate on earth and it actually protects organisms from the sun's harmful ultraviolet radiation. So we so slowly start seen ferns and mosses begin to migrate on earth. And they produce vast forests, which will eventually die, be overlain by rock, and under intense heat and pressure can actually produce some of the coal that we use to heat and warm our houses today or produce other energy that we use.

Also during this time roughly 400 million years ago, we see tetrapods and early amphibians move on to terrestrial land to consume the vegetation that has moved out of the aquatic environment. And reptiles evolve. And what is so unique about reptiles is they actually figure out a way to reproduce on land by incorporating calcium carbonate in their shells. Amphibians and fish-- or most amphibians, are restricted to laying their eggs in water. So now we're going to talk about the Mesozoic era.

[MUSIC PLAYING]

So we've reached our third stop along the geologic time walk. We've walked through the Devonian and the early lobe-finned fishes. We've seen the birth of sharks. And we've traveled through the carboniferous. And now we reach one of the great mass extinction events. This is known as the Great Dying. It's the Permian-Triassic Mass Extinction Event.

And we believe that this extinction event was brought on by great super volcano in Siberia. So this super volcano ejects a lot of soot into the atmosphere, which not only clouds the atmosphere and kills a lot of photosynthetic life. But it also introduces a great abundance of carbon dioxide and sulfur dioxide into the atmosphere, which combines with rain to produce sulfuric acid.

So the combination of these events really causes a Great Dying event, wiping out 90% to 95% of life on earth. And it kind of almost clears the slate for a new organism to dominate and take the next stage. So in our next stop, we'll talk about the rifting of Pangea and the breakup of the super-continent that had formed during the Paleozoic.

[MUSIC PLAYING]

So we just witnessed the Permian-Triassic mass extinction that wiped the earth clean for the next class of organisms to take over and dominate. We also talked about plate tectonics and seafloor spreading has caused Pangea, the super-continent at the time, to rift and break apart.

This process begins roughly 225 million years ago. And we start to see a juvenile ocean. It's kind of the precursor of the Atlantic Ocean. And it's called the Tethys Sea. It's a very shallow area. And what's so significant about this area is the currents really bring a lot of nutrients, which cause phytoplankton blooms. And this brings fish by the millions.

As these fish die, they later the ocean floor and are eventually overlain by other material. And over hundreds of millions of years and great pressure and intense heat, this actually produces oil, which we harvest today to power our cars and for many other energy purposes. So this process continues.

The continent continues to break apart. And over the next 30 million or 40 million years, it starts to resemble a configuration that we can recognize today where the Americas are thousands of miles away from Africa, Europe, and Asia. During this time period, a new class of organisms dominate the planet.

Originally, it was kind of more fish during the Paleozoic and maybe tetrapods, anthropods, on land. But after this Permian Triassic extinction event, this sets the stage for the dinosaurs. So we're going to continue along our time walk and start talking about the dinosaurs now.

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