PROGRAM OVERVIEW

Thank you for booking Planet Earth with Royal Tyrrell Museum Distance Learning!

Join us as we journey through time to discover the history of our planet. Students will work in teams to answer questions related to our planet's composition, geologic activity, and rich fossil history. This program is formatted to cover aspects of Alberta's grade 7 curriculum, while challenging students to work collaboratively towards a better understanding of our planet's past.

Audience:

Grades 6–9 * (maximum 35 students)

Alberta curriculum connections:

Grade 6 Science (Evidence and Investigation, Trees and Forests)
Grade 7 Science (Planet Earth, Interactions and Ecosystems)
Grade 8 Science (Freshwater and Saltwater Systems)
Grade 9 Science (Biological Diversity)

PROGRAM OBJECTIVES

Participants will:

1. Identify the different layers of Earth's internal structure
2. Review rock and minerals types and properties
3. Understand the driving force behind plate tectonics
4. Learn the three different plate boundary types
5. Understand how organisms change over time
6. Learn about geologic time and how it is divided (e.g., eras, periods, etc.)
7. Work as a team to answer questions related to geology and palaeontology
8. Discover how fossils form and the different types of fossilization
9. Understand how scientists interpret the fossil record
10. Explore how plants, animals, and associated food webs adapt to change
11. Learn about the three types of weathering
12. Review the importance of erosion and deposition

PROGRAM FORMAT

~45 minutes

1. Introduction

2. Precambrian Super-Eon
    a. Earth's internal structure
    b. First life

3. Game Play – Precambrian
    a. Questions may include topics like rock type, mineral properties, the age of our planet

4. Palaeozoic Era
    a. Plate tectonics and three plate boundaries
    b. Convection and slab pull
    c. Changes to the continents and life over this era
    d. Geologic time scale

5. Game Play – Palaeozoic
    a. Questions may include topics like rock folds, volcanism, plate boundaries, and fauna

6. Mesozoic Era
    a. Types of fossilization
    b. Animals of the Mesozoic
    c. How scientists interpret the fossil record
    d. Evidence for a supercontinent
    e. Extinction of the dinosaurs

7. Game Play – Mesozoic
    a. Questions may include topics like fossilization, law of superposition, mass extinctions, fossil evidence, and supercontinent evidence

8. Cenozoic Era
    a. Food webs and disruptions
    b. Types of weathering (chemical, biological, and mechanical)
    c. Erosion and Deposition
    d. Formation of the Alberta badlands

9. Game Play – Cenozoic
    a. Final question: weathering types

CORE CONTENT

Earth's Structure

Our planet formed 4.6 billion years ago during the Precambrian super-eon. Over 500 million years, our planet settled into its current internal configuration, with four distinct layers:

1. **Inner Core:** believed to be solid with a temperature of ~7000ºC and ~1250 km thick and is composed of iron and nickel metals.

2. **Outer Core:** a molten layer of iron and nickel metals that is ~2200 km thick. The flow of the liquid metal is what causes our planet to have a magnetic field.

3. **Mantle:** the thickest and heaviest at ~2900 km and ⅔ of our planet's mass. It is a solid made from mostly iron and magnesium silicates that slowly flow through heat-driven convection.

4. **Crust:** the outermost layer, it is the thinnest of all layers between ~10 - 90 km thick. It is a solid and made of many rocks and minerals and is where fossil fuels are found.

Geology

Our planet is home to many types of rocks and minerals, which are studied by geologists. These rocks can be divided into three main classifications:

1. **Sedimentary Rocks:** formed when small pieces of rock called sediments are carried by water or wind and settle or sink down in water on top of the rocks below them (e.g., sandstone). Some also form from the accumulation of the remains of minerals excreted by living things that are broken down and compacted over time (e.g., limestone).

2. **Igneous Rocks:** formed from hot, molten rock. If formed under the surface of our planet from magma, it is considered intrusive igneous and often forms large crystal structures from the slow cooling of the minerals (e.g., granite). If formed on the surface of our planet from lava, it is considered extrusive igneous and cools quickly (e.g., basalt).

3. **Metamorphic Rocks:** rocks that have been altered or transformed through the active forces of intensive heat and / or pressure under the surface (e.g., gneiss, marble).

The rocks that make up the Alberta badlands are sedimentary rocks that have accumulated to form stratified layers. Based on the Law of Superposition, these layers are arranged with the oldest layers appearing on the bottom, and the youngest on top.

All rocks are made of small, naturally occurring materials known as minerals. There are six properties that we can test to determine the different types of minerals:

1. **Colour**: the colour that the mineral appears to be when you look at it.
2. **Lustre**: the way the surface of the mineral reflects light.
3. **Streak**: the colour of the powder left behind when it is rubbed against a rough surface.
4. **Cleavage**: how a mineral splits evenly into multiple surfaces.
5. **Fracture**: how a mineral breaks unevenly into rough surfaces.
6. **Hardness**: how easily a mineral can be scratched. This can be determined using Mohs Hardness Scale.

Plate Tectonics

Our planet's lithosphere (made of the crust and upper portion of the mantle), moves at a slow but steady rate, causing the continents to change location and shape over time. These plates have edges that have been termed plate boundaries where each plate meets. There are three main types of plate boundaries:

1. **Diverging Boundary:** where two plates move apart from one another. This is where new crust forms as magma flows up to the surface.

2. **Converging Boundary:** where to plates move towards each other. The collision of these plates causes earthquakes, mountain building, and volcano formation. When a heavier plate slides below a lighter plate, it is called subduction (e.g., Ring of Fire). When two plates of equivalent density collide, it forces the crust upwards, forming mountain chains (e.g., Himalayas). When the rock is forced into an upward fold, it is called an anticline, and when it is forced into a downward fold, it is called a syncline.

3. **Transform Boundary:** when two plates slide sideways past each another. The grinding of these plates against one another can cause earthquakes to shake the ground above.

The driving force behind the slow movement of these plates is due to slow motions within the mantle of our planet. Heat from the core moves through the mantle towards the lithosphere. As it nears the surface, heat is lost forcing the mantle rock back down towards the core where it heats once more. This circular potion of heat transference is called convection. As the edges of subducting plates are forced into the mantle, it also causes gravity to assist with the spreading of these plates through a process known as slab pull. These motions together cause the mass movement of Earth's tectonic plates.

Over time, the plates carry the continental crust across the face of the Earth, changing the configuration of the continents. Between the end of the Permian Period and the early part of the Jurassic Period, all of the planet's continents had joined together to form a supercontinent known as Pangaea. Evidence for this includes:

- Plant and animal fossils are concentrated in continents that are adjacent from one another.
- Mountain ranges and coal deposits continue across ocean gaps onto adjacent continents.
- The shapes of the continents fit together like puzzle pieces, matching up the geologic evidence above.

Biodiversity Over Time

Throughout our planet's history, there have been major changes to the type, abundance and the adaptations of living things that allow them to better survive over time. Some of the major transitions of life took place during each time period spanning from 600 million years ago to the present day:

- **Ediacaran Period:** simple, soft-bodied, multicellular organisms appear in rocks approximately 575 million years old.
- **Cambrian Period:** a rapid radiation of animal phyla occurred approximately 541 million years ago, (e.g., fossils of the Burgess Shale in the Canadian Rockies.)
- **Ordovician Period:** most marine invertebrates that are still around today emerged at this time, as did the first fishes.
- **Silurian Period:** plants and animals like arthropods colonized the land.
- **Devonian Period:** large armoured fish known as placoderms dominated the oceans, while tetrapods developed arm-like appendages, allowing the vertebrates to start invading the land.
- **Carboniferous Period:** swamps covered much of the planet and oxygen levels were as high as 32%, allowing for super-sized insects to evolve. Reptiles first appeared in the fossil record.

- **Permian Period:** reptiles dominated the land, each of these groups of reptiles represented early ancestors of later derived animals including archosaurs, lizards, turtles, and even mammals.
- **Triassic Period:** several animal groups first appeared including dinosaurs, mammals, crocodilians, pterosaurs, and ichthyosaurs.
- **Jurassic Period:** first birds appeared during this time and iconic dinosaur lineages including the spiked stegosaurs, long-necked sauropods, armoured ankylosaurs, and carnivorous allosaurs dominated.
- **Cretaceous Period:** dinosaurs continued to rule with the frilled ceratopsians, bird-mimic ornithomimids, fierce tyrannosaurs, and crocodile-like spinosaurids. Flowering plants started to appear at this time, and insect diversification took place as a result.
- **Palaeogene Period:** mammals diversified with the appearance of whales, horses, primates, bats, pigs, dogs, and cats.
- **Neogene Period:** grasslands spread with the cooler, drier temperatures. Many ruminants evolved such as bison, camels, sheep, and giraffes. In the oceans, kelp started to appear as did the large shark *Carcharocles megalodon*.
- **Quaternary Period:** the climate cooled further, launching our planet into the ice ages. Cold hardy species like wooly mammoths, mastodons, wooly rhinos, musk ox, and sabre-toothed cats ruled the land.

Palaeontology

Palaeontology is the study of ancient life based on the fossil record. A fossil is the remains, traces, or imprint of a prehistoric organism preserved in rock. There are several ways that fossils can form depending on environmental conditions.

- **Permineralization:** when minerals fill the spaces within organic tissues and create a natural internal cast of the organism.
- **Replacement:** when minerals replace the organic minerals of the organism, creating an exact reproduction of the original.
- **Carbonization:** when organisms are buried in low oxygen environments and the residual carbon of that organism is left in the rock, often in two-dimensional form.
- **Amber:** the fossilized resin of trees that has hardened through polymerization into a plastic-like consistency. These gemstones often contain the remains of organisms that had become trapped in the sap such as insects, plants, and even feathers.
- **Casts / Molds:** the impressions of an organism left behind (mold), sometimes these are subsequently filled in by sediments that harden, creating a replica of the original (cast).

Some fossils are not from the organisms themselves, but traces they have left behind. These trace fossils give palaeontologists insight into how those organisms behaved. Some examples include trackways, burrows, and coprolite (fossilized feces).

By studying fossils, palaeontologists been able to understand how living organisms were able to adapt to change over the course of our planet's history.