NORTH CAROLINA GEOLOGIC TIMELINE

Students will walk through Earth's geologic time while hiking through the forest. Each event occurs at a certain distance from the starting point. At each major event, the students will explain what happened in Earth's geologic time and North Carolina's.

LESSON LENGTH:

- 4 hours

GOALS:

- To provide students information about North Carolina's geologic time and to give an overview of the last 4.5 billion years of Earth history.

OBJECTIVES:

Students will be able to:

- Contextualize geologic time using reference scales
- Learn geologic highlights of North Carolina

GALS would like to specifically acknowledge Mary Gianotti for her contributions to this lesson plan.

NATIONAL, STATE, LOCAL STANDARDS

- North Carolina Standard Course of Study
  - EEn.2.1 Explain how processes and forces affect the lithosphere.
    - EEn.2.1.1 Explain how the rock cycle, plate tectonics, volcanoes, and earthquakes impact the lithosphere.
    - EEn.2.1.2 Predict the locations of volcanoes, earthquakes, and faults based on information contained in a variety of maps.
  - EEn.2.7 Explain how the lithosphere, hydrosphere, and atmosphere individually and collectively affect the biosphere.
    - EEn.2.7.1 Explain how abiotic and biotic factors interact to create the various biomes in North Carolina.

STUDENT TAKEAWAYS FROM LESSON:

- Essential question / theme
  - Walking through geologic time to illustrate the scope of Earth's history
- Key concepts and vocabulary
  - Uniformitarianism: the theory that changes in the earth's crust during geological history have resulted from the action of continuous and uniform processes.
  - Radioactive dating: a means of determining the "age" of a mineral specimen by determining the relative amounts present of certain radioactive elements
  - Geologic time: the extensive interval of time occupied by the geologic history of Earth. It extends from about 4.6 billion years ago (corresponding to Earth's initial formation) to the present day.

ASSESSMENTS:

- Before each stop, the students are asked to provide a brief review of what already took place in Earth's geologic history.
- Journal entry

DIVERSITY (REACHING STUDENTS OF ALL LEVELS/ABILITIES):

- Every student is able to participate in the activity

MATERIALS & EQUIPMENT:

- Geologic timeline cards (print back to back with Earth events on one side and NC events on the other)
- Geologic timeline spreadsheet (enter distance to calibrate for the hike)
- Map of hike (to keep track of distance)
- Watch (to time approximate distances)
- GPS/pedometer (optional- for more exact measure of distance)

LOCATION:

- Outside space with at least 3 miles available

RISK MANAGEMENT & SAFETY CONCERNS:

- Ensure that all students are prepared physically for the hike with proper clothing, enough food/snacks and water.

BAD WEATHER ALTERNATIVE:

- If short on time, choose the really huge events to harp on during the hike. Then fill in the rest of the events during a follow-up time.
- Also, if short on time or the weather is not conducive for a long hike, do the initial discussion in E*xplore* and understanding magnitude in *Explain*.

PRE-LESSON PREPARATION:

- Plan out the hike as it relates to the geologic timeline.

LESSON:

ENGAGE

- Inform students that today they will embark on a several-mile hike to portray geologic time and discuss some major events that happened from 4.5 billion years ago to today.
- Discussion of scale
    - This should be an interactive discussion with students, where the instructor asks leading questions to help them reach conclusions on their own.
        - *When did the earth form*? (4.55 billion years ago)
        - *How do we know that?* (radioactive dating of old uranium rocks)
        - *How do geologists know what rocks mean?*
            - **Uniformitarianism** – the present is the key to the past. By studying present depositional environments, we can understand how different processes on the surface of the earth form different rock types (i.e., lakes deposit sediments in layers).
            - The history of the last billion years is well recorded in the rocks, much like pages in a book. On a scale of millions of years, continents and oceans form and disappear, change in shape, and move. Mountains rise out of the sea and later wear down to their roots.

EXPLORE

- Understanding orders of magnitude:
    - *So how long ago is 4.55 billion years ago?*
        - Draw a line on the ground (about 10 feet is good), and mark edges with something.
        - Give each student a twig or leaf.
        - Tell students this line represents 1 billion years.
        - Ask them to place their twig where they think one million years is (most will place it somewhere between 100 – 400 million).
        - Show them that 1 million is actually only 0.1% of 1 billion, so on a 10-foot line, that would fall at 0.12 inches from zero.
- Geologic Hike
    - *For this hike, we will walk through geologic time by spreading out important events in earth's history over the course of a hike* (this can be adjusted to any length, but about 3 miles works well).
    - Pass out geologic event cards (keeping the formation of earth card for the instructor).
    - Tell students to look at their card(s) and make sure they know what years they took place but not to show them to anyone else.
    - Start the hike by saying: *This story is based on what geologists discovered by mapping, measuring, and sampling rocks of this region for more than a century and by fitting those observations into the worldwide geologic puzzle that is the history of the Earth.*

- *Okay! It is 4.5 billion years ago, and gravity just pulled together a dense pile of rock out of a swirling cloud of rocks and molten minerals. This is Earth now!*
- Show them your card.
- Once the hike begins, the instructor will keep track of distance using a GPS or a map/watch and will let students know when landmarks are reached.
- At each landmark, ask students – *"Who knows what happened _____ (i.e. 3.8 billion years ago)?"* The student with that card should tell the rest of the group what event occurred. On the back of each card is the current geologic state of North Carolina. Ask students to share this information as well.
- Elaborate on the event for the students: provide context and paint a picture of what the earth and North Carolina would have looked like at that time in the past.
    - If possible, each landmark should also have a geologic feature that could provide a visual reference.
- Before beginning the next stop, ask the students to provide a brief review of what was going on in Earth's geologic history.
- Continue the journey, stopping at important points and allowing students to ask questions.
- Once you have reached less than 1 million years ago, tell students to take off their packs to finish the hike. There will only be tens of feet left at this point, and there are many many stops, some only inches apart.
- NOTE: See Appendix 1 for extra information about the Carboniferous period and the Quaternary Glaciation period

EXPLAIN

- Reflect on the hike.
    - *Were you surprised how long it took for anything interesting to happen?*
    - *Did you think it was strange that these big old looking mountains we are hiking in have only been here for a few hundred feet of our hike?*
- The instructor should facilitate a discussion about how the collision of land masses relates to biodiversity, humans, and ways of life. This discussion is meant to promote the connection of then to now and also speak on "Why do we care?" about this topic.
    - *The collision of continents hundreds of millions of years ago also set the stage for the patterns of human settlement, travel, and transportation routes in the region. The northeast-southwest-trending ridges and valleys were both the main routes of travel for people and ideas and, at the same time, barriers to travel.*
    - *The location of industry, and subsequently, the location of population centers, was based on availability of raw materials and transportation routes.*

EVALUATE

- Ask students to answer the following question in their journals, and then share out with the group:
    - *Did you notice geologic features on this hike that are similar to those in your town or city?*
    - *Based on your knowledge of Earth's geologic history, hypothesize what the state of Earth was when those features formed in your city.*

REFERENCE MATERIALS/RESOURCES

- USGS: Birth of the Mountains The Geologic Story of the Southern Appalachian Mountains
    - https://pubs.usgs.gov/gip/birth/birth.pdf

APPENDIX 1: SUPPLEMENTARY INFORMATION

Carboniferous period – This period is famous for its vast swamp forests. Such swamps produced the coal from which the term Carboniferous, or "carbon-bearing," is derived. In addition to having the ideal conditions for the formation of coal, several major biological, geological, and climatic events occurred during this time. Biologically, we see one of the greatest evolutionary innovations of the Carboniferous: the amniote egg, which allowed for the further exploitation of the land by certain tetrapods. It gave the ancestors of birds, mammals, and reptiles the ability to lay their eggs on land without fear of desiccation. Climatically, there was a trend towards mild temperatures during the Carboniferous, as evidenced by the decrease in lycopods and large insects as well as an increase in the number of tree ferns. The Mississippian environment of North America was heavily marine, with seas covering parts of the continent. As a result, most Mississippian rocks are limestone, which are composed of the remains of crinoids, lime-encrusted green algae, or calcium carbonate shaped by waves. The North American Pennsylvanian environment was alternately terrestrial and marine, with the transgression and regression of the seas caused by glaciation. These environmental conditions, with the vast amount of plant material provided by the extensive coal forests, allowed for the formation of coal. Plant material did not decay when the seas covered them, and pressure and heat eventually built up over millions of years to transform the plant material to coal.

Quaternary Glaciation (Pleistocene Glaciation): This was the last 10% of the Current Ice Age, in which the previous long-term glaciation of Antarctica has spread to the northern hemisphere. During this period, ice sheets expanded, notably from out of Antarctica and Greenland, and fluctuating ice sheets occurred elsewhere. Major effects of the ice age were the erosion of land and deposition of material over large parts of the continents, the modification of river systems, the creation of millions of lakes, changes in sea level, the development of pluvial lakes far from the ice margins, the isostatic adjustment of the earth's crust, flooding, and abnormal winds. The ice sheets themselves, by raising the albedo (extent to which the energy of the sun is reflected from Earth), created significant feedback to further cool the climate.