

Geologic Timeline Teacher Guide

In this activity students will:

1. Examine temperature, CO₂ concentration, and ice cover data to investigate how climate has changed during the last 715 million years.
2. Understand that long term climate patterns provide evidence for fluctuating CO₂ concentrations.
3. Record and analyze a long-term global climate data set.

In this learning activity, students will use a Web-based Geologic Timeline to understand how Earth's climate has changed during the last 715 million years. Nine distinct time periods are displayed on the timeline ranging from the present day to 715 million years ago. Students will examine and interpret global temperature, CO₂ concentration, and ice cover data to infer what the global climate was like during a specific time period and relate this evidence to the current global warming discussion.

Model the following procedural instructions with your students. It is recommended that you display your computer image at the front of the classroom. It is recommended that this activity be completed with a Firefox Web browser.



Step 1: Download Data

1. Open your Web browser. Go to www.ei.lehigh.edu/learners/cc/.
2. Click **Geologic Timeline**.



Step 2 : Geologic Timeline Overview




The Geologic Timeline shows the average global temperature, CO₂ concentration (ppm), and the percent of global ice cover for nine distinct time periods throughout Earth's history. The pictures associated with each time period depict the location of the landmasses during that time period. They also show the distribution of ice cover for that time period.

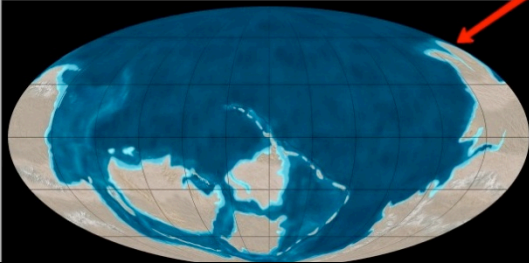
1. The Geologic Timeline opens with a column of row labels on the left hand side and a scrolling timeline that moves to the right.

| Geologic Timeline | | | | | | | | | |
|---|--|-----------|---|------------|----------|---|---------------|---------|----------|
| Year | 850 ma | 635 ma | 542 ma | 448 ma | 444 ma | 416 ma | 359 ma | 299 ma | 252 ma |
| Era | Neoprotozoic | | | Paleozoic | | | | | |
| Period | Cryogenian | Ediacaran | Cambrian | Ordovician | Silurian | Devonian | Carboniferous | Permian | Triassic |
| Exploration Image | | | | | | | | | |
| | Click here to explore 715 ma | | Click here to explore 540ma | | | Click here to explore 300ma | | | |
| Annual Global Temperature | -4 °C | | 22 °C | | | 12 °C | | | |
| Annual Global CO ₂ Concentration | ~100ppm | | 7000 ppm | | | 350 ppm | | | |
| % Global Ice Cover | ~85% | | 0% | | | 20% | | | |

2. The timeline rows include:
 - a. Year – The years shown encompass the extent of the era in the second row.
 - b. Era – One of the three long units of geologic time between the Precambrian and the present.
 - c. Period – One of the units of geologic time into which geologists divide eras.

- d. Exploration Image – A thumbnail picture of the locations of the landmasses during that time period and the amount of ice cover.
- e. Annual Global Temperature – The average global temperature for the time period of interest.
- f. Annual Global CO₂ Concentration – The average global CO₂ for the time period of interest.
- g. % Global Ice Cover – The % global ice cover for the time period of interest.
3. The small thumbnail picture associated with each year is an “exploration image.” When the thumbnail picture is selected a larger image will appear with a text box at the bottom of the screen. The text box contains additional information about the climate during that time period.

| Period | Cryogenian | Ediacaran | Cambrian | Ordovician | Silurian | Devonian | Carboniferous |
|---|---|-----------|--|------------|----------|----------|--|
| Exploration Image |  Click here to explore 715 ma | |  Click here to explore 540ma | | | |  Click here to explore 300ma |
| Annual Global Temperature | -4 °C | | 22 °C | | | | 12 °C |
| Annual Global CO ₂ Concentration | ~100ppm | | 7000 ppm | | | | 350 ppm |
| % Global Ice Cover | ~85% | | 0% | | | | 20% |



540 Ma Cambrian Explosion
Rapid evolutionary processes at this time lead to the appearance of many new life forms. Evidence from the fossil record indicates that most major types of organisms appeared at this time. An ancient Atlantic Ocean, the Iapetus Ocean, was opening and beaches rimmed the North American continent.

4. The Geologic Timeline includes the following abbreviations that should be reviewed with your students:
- CO₂ - carbon dioxide
 - ppm - parts per million
 - Ma - millions of years ago
 - ka - thousands of years ago

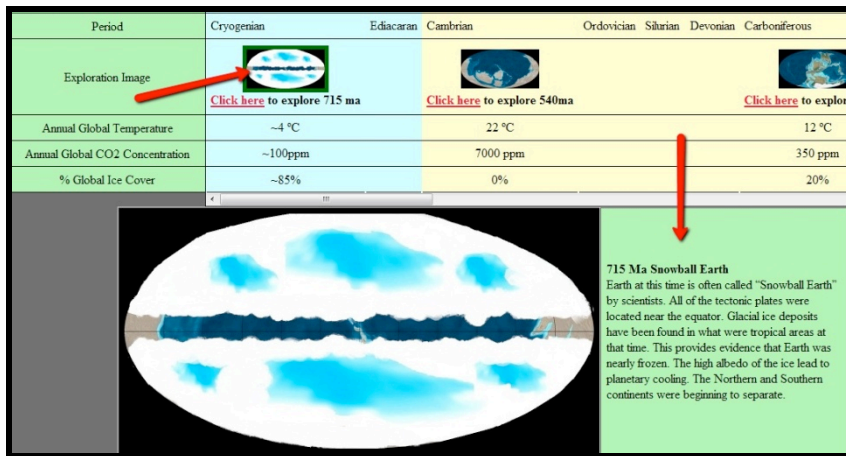
Note: It is important to remind your students that the Geologic Timeline years in the timeline are not to scale.



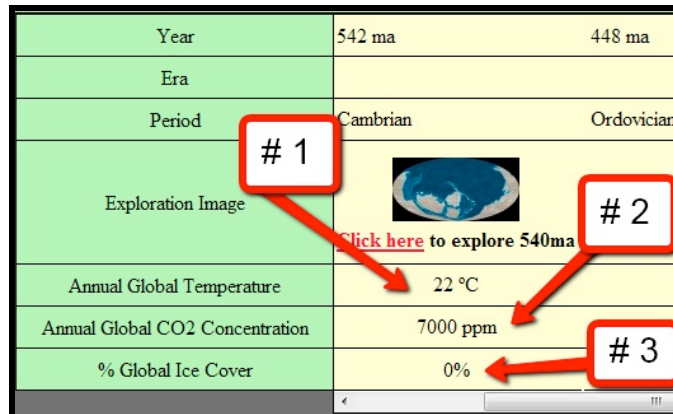
Step 3 : Using the Geologic Timeline

- The Geologic Timeline includes 9 time periods that show a range of climates that occurred during Earth's history. The reconstructions used for this activity are for the time periods:
 - 715 million years ago
 - 540 million years ago
 - 300 million years ago
 - 100 million years ago
 - 2 million years ago
 - 50 thousand years ago
 - 10 thousand years ago
 - 1880
 - 2010

- The entire Geologic Timeline can be viewed by using the scroll bar underneath the last row of text. The first few time periods are initially displayed. Students will need to scroll to the right in order to access the rest of the time periods.
- Clicking on the “**Exploration Image**” associated with each time period will display a text box below the timeline that contains additional information about that time period.
- Display the 715 Ma time period to your students as shown in the image below.



- Show them the “Exploration Image” picture and where to locate the Annual Average Global Temperature, Annual Average CO₂ Concentration, and the % Global Ice Cover for that time period.



Step 3 : Geologic Timeline Analysis

- Beginning with the 715 Ma time period, the students should select the small “**Exploration Image**” icon and read the text in the box that appears.

2. Instruct students to record the **Annual Average Global Temperature, Annual Average CO₂ Concentration, and the % Global Ice Cover** in the data table provided on the **Student Exploration Sheet**.
3. After the students have recorded the data for the 715 Ma time period, they should repeat this process and gather data for the eight other time periods. All data should be recorded in the table as shown below on the **Student Exploration Sheet**.
4. Instruct students to follow #2 and plot the data from their data table onto the provided graph and answer questions #3-4 on the **Student Exploration Sheet**.

Implementation Suggestion: Some low-ability students may require additional support with plotting the Average Global CO₂ Concentration data on the graph. You may wish to explicitly model how to plot points that are less than 1000 ppm on the Average Global CO₂ Concentration graph.

5. Instruct students to answer **Analysis Questions # 5-8** on the **Student Exploration Sheet**. The questions should be answered in complete sentences.