Title: Paleoclimate with Forams

Grade: \_\_9-12\_\_\_\_\_

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| **Objective** | * To understand what a foraminifera is * To be able to analyze δ18O curves * To use δ18O curves to make predictions * To understand and explain how scientists use forams to understand glacial cycles |
| **Standards** | **NGSS**:  High School Earth Science courses correlate with a variety of topics, for example:  [Earth and Human Activity](https://www.nextgenscience.org/pe/hs-ess3-5-earth-and-human-activity)  [Earth’s Systems](https://www.nextgenscience.org/topic-arrangement/hsearths-systems)  **CSS**:  Speaking and Listening:  [9-10](http://www.corestandards.org/ELA-Literacy/SL/9-10/4/) Standards  [11-12](http://www.corestandards.org/ELA-Literacy/SL/11-12/) Standards  Literacy in Science & Technical Subjects:  [9-10](http://www.corestandards.org/ELA-Literacy/RST/9-10/) Standards  [11-12](http://www.corestandards.org/ELA-Literacy/RST/11-12/) Standards  **For states that don’t use Common Core or Next Generation Standards:**  TN [Environmental](https://www.google.com/url?q=https://www.tn.gov/content/dam/tn/education/standards/sci/std_sci_3260.pdf&sa=D&ust=1525194003422000&usg=AFQjCNHSHHn5PDf47o5BheAXFBplZcAV0Q) Standards  TN [Earth Science](https://www.google.com/url?q=https://www.tn.gov/content/dam/tn/education/standards/sci/std_sci_3204.pdf&sa=D&ust=1525194003412000&usg=AFQjCNFr9DxzBWnNYSEx60gjwBj4SzKqYg) Standard |
| **Science Background** | Foraminifera, also referred to here as *forams*, are a type of microscopic organism, that live in the ocean. Forams can be either benthic, meaning they live on the ocean floor, or planktic, meaning they float in the water column. These organisms can be preserved as fossils and used by scientists to make inferences about what paleoclimates were like. One example is the isotope information recorded in foram fossils. This lesson will focus on graphs that show the change in oxygen isotopes throughout geologic time. Each of the elements on the periodic table has a set number of protons and neutrons, but there can be isotopes of different elements that have the same number of protons, but a different number of neutrons.There are two particular oxygen isotopes that paleoceanographers typically focus on, 18O and 16O, both of which are found in ocean water! 18O is a heavier isotope than 16O, meaning that when leaving the ocean, 16O is more likely to leave the body of water, while the heavier 18O will be left in the ocean. Similarly, when this water condenses again and begins to precipitate, the heavier 18O isotope will leave the weather system first. During times when Earth was colder, foram fossils will have more 18O present in their shells because there is more 18O in oceans. The reverse is also true, during times when the Earth was warmer, foram fossils will have less 18O present in their shells. So, we can use these changes in oxygen isotopes to better understand past climatic conditions. |
| **Required Materials** | * Access to [myFOSSIL website](https://www.myfossil.org/members/sumrall-labgroup/ac_media/) or printed foram models * (Optional) Print copies of compare/contrast worksheet for lesson launch * Worksheets specific to each section of the curve, one copy per student in the group * Print different segments of δ18O curve |
| **Before the Lesson** | **Lesson Launch Activity:**  (Optional) K-5 level activity on intro to forams to give students a frame of reference for what a foram is and how many types there are  Discuss foraminifera and their utility in the geosciences, use Time Scavengers for content: <https://timescavengers.blog/paleo-live/our-research-explained/foraminifera/> |
| **During the Lesson** | **I do:**  The teacher will give a short introduction to the lesson to review students’ knowledge of core concepts like isotopes, climate change, even graphs.   * Climate Change information pages: <https://timescavengers.blog/climate-change/> * Isotope information: <https://timescavengers.blog/climate-change/> * Carbon & Oxygen Isotopes: <https://timescavengers.blog/introductory-material/what-is-paleoclimatology/proxy-data/carbon-oxygen-isotopes/>   **We do:**  Students will be broken into small groups and assigned a section of the glacial curve. In each group, students will construct a table identifying isotopes for specific years in order to ensure that they understand the data. During this activity, the teacher will circulate and prompt students with questions to connect what they learned from the lesson with the data on their graphs.  **You do:**  Outside of class, students will produce a write-up of their activity including a summary of what they learned and an analysis of what they would like to change in the activity |
| **After the Lesson** | **Summary:**  After completing their activity in small groups, students will return to the whole class and share their predictions about what the curve would look like in the future. The teacher will ask students why they think there is no data from older time periods and explain the way that data is lost when tectonic plates subduct back into the mantle.  **Assessment:**  Based on age/ability, students will be able to, as a group, identify the parts of a graph, understand and explain the information shown, then make a prediction about the future and support it with facts. After class, students will type or write a summary of the materials used in the lesson, what they observed, what they think was successful, and what they would change in future activities. |