

## **Acidification of the Oceans at the time of KPg event and Now**

### **Overview**

In this unit, students will explore the evidence of how the dinosaurs died. They will investigate how the sizes of foraminifera (forams) changed to support the KPg boundary. They will then correlate the sizes and changes of forams today to infer if there is extinction happening today due to anthropogenic causes.

### **Standards (NGSS)**

#### **HS-ESS1-6: Evidence of the Earth's History**

Apply scientific reasoning and evidence from ancient earth materials, meteorites, and other planetary surfaces to construct an account of earth's formation and early history. (Stability and Change)

#### **HS-ESS2-2: Feedback in Earth's Systems**

Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other earth systems. (Stability and Change)

#### **HS-ESS2-6: Carbon Cycling in Earth's Systems**

Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (Energy and Matter)

#### **HS-ESS2-7: Coevolution of Life and Earth's Systems**

Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (Stability and Change)

#### **HS-ESS2-4: Energy Variation and Climate Change**

Use a model to describe how variations in the flow of energy into and out of earth's systems result in changes in climate. (Cause and Effect)

#### **HS-ESS3-5: Climate Change and Future Impacts**

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to earth systems. (Stability and Change)

#### **HS-ESS3-1: Global Impacts on Human Activity**

Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (Cause and Effect)

### HS-ESS3-6: Human Impacts on Earth Systems

Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (Systems and System Models)

### HS-LS2-2: Biodiversity and Populations in Ecosystems

Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (Scale, Proportion, and Quantity)

### HS-LS2-6: Ecosystem Dynamics, Functioning, and Resilience

Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

### HS-LS2-7: Human Impact Reduction Solution

Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Stability and Change)

### HS-LS4-5: Environmental Change - Speciation and Extinction

Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (Cause and Effect)

### HS-PS1-11: Acids and Bases

Plan and conduct an investigation to compare properties and behaviors of acids and bases.

## Key Concepts

### Learning objectives:

Students will be able to:

- Provide evidence to support the asteroid impact that caused the extinction of the dinosaurs.
- Students will analyze the size and shell structure of foraminifera before and after the KPg event.
- Research ocean acidification before and after the KPg event.
- Analyze forams today and relate it to the acidification of oceans today.
- Propose a claim, utilizing data as evidence and discuss their reasoning to support the current acidification of today's oceans and further predict impacts of marine ecosystems.

### Time Requirements

This unit is designed as a 5E model lesson plan with a 2-week time period.

### Suggested Audience

This activity is appropriate for high school Earth Science and living environment students.

### Prior Knowledge

Students should have an understanding of other celestial objects in space.

Students should have an understanding of climate, global warming, and climate change.

Students should be familiar with the pH scale.

Students should be able to have the skill set of measuring using metrics.

Students should know that humans add large quantities of CO<sub>2</sub> into the atmosphere causing changes to global warming and the acidification of oceans. ??????????

## Description and Teaching Methods

### Engage

1. Introduce the KPg event (Crater of Doom story book) - carousel activity for discussion

Book: [Into the Crater of Doom: A Free Children's Book](#)

Kurtz, K. (n.d.). Into the Crater of Doom. Retrieved February 16, 2021, from <https://joidesresolution.org/wp-content/uploads/2020/02/Into-the-Crater-of-Doom.pdf>

Questions: [Into the Crater of Doom questions](#)

Cards:

<https://docs.google.com/document/d/1yUDyjTaEI0oqM8533OE4R41O37PctrDhDGV2mCRM5Hc/edit?usp=sharing>

2. Watch "The Day the Mesozoic Died." - worksheet on evidence presented and what does the evidence suggest. Discuss as class and add to KPg poster

The day the MESOZOIC DIED. (2020, May 14). Retrieved February 16, 2021, from <https://www.biointeractive.org/classroom-resources/day-mesozoic-died>

Worksheet: [Day the Dinosaur Died Evidence Table](#)

Students will watch the program and then discuss what does the evidence suggest? A worksheet will be provided for students to match the evidence with what the evidence suggests.

Cards:

[Evidence Cards](#)

## Explore

1. Look at sediment core from the Chicxulub crater (KT Impact event kit) to further understand the evidence of KPg event - Look at cores and forams and annotate the LabBook: Core Description

[Directions for chicxulub crater core](#)

[Lab Book Description Card:](#)

<https://joidesresolution.org/wp-content/uploads/2017/08/Lab-Book-Core-Description-Card.pdf>  
(n.d.). Retrieved February 18, 2021, from  
<https://joidesresolution.org/wp-content/uploads/2017/08/Lab-Book-Core-Description-Card.pdf>

[KPg Core and Forams:](#)

KT core And forams.pdf. (n.d.). Retrieved February 18, 2021, from  
<https://joidesresolution.org/wp-content/uploads/2017/08/Using-the-Cretaceous-Impact-Kit-for-Science-Process.pdf>

2. Why Study Forams? (Mohawk Guy activity) Students will read the info and answer questions.

[Why Study Forams Reading:](#)

MOHAWK GUY AND HIS BAND OF NEOGENE PLANKTIC FORAMINIFER FRIENDS.  
(n.d.). Retrieved February 18, 2021, from <https://joidesresolution.org/activities/mohawk-guy/>

Question: [Why Study Forams?](#)

3. Acidification Lab - See student handout

[Lab: Ocean Acidification \(HHMI - biointeractive\)](#)

Extension - add a few drops of distilled water to a beaker to get the pH to a level of 7.9, the projected pH of oceans by 2050. Set up a few beakers of today's oceanic pH and the forecasted oceanic pH by 2050. Students should make observations of the chalk before placing chalk in the beakers. After a few days, have students take out the chalk and observe the dissolution of the chalk.

Ocean acidification. (2020, April 30). Retrieved February 18, 2021, from <https://www.biointeractive.org/classroom-resources/ocean-acidification>

## Explain

1. Analyze the biodiversity of forams before and after the KPg event.- Compare and contrast the shell structure and size of forams before and after the KPg event.

<https://www.biointeractive.org/classroom-resources/weighing-evidence-mass-extinction-ocean>)

Weighing the evidence for a mass extinction: In the ocean. (2017, October 30). Retrieved February 18, 2021, from <https://www.biointeractive.org/classroom-resources/weighing-evidence-mass-extinction-ocean>

2. Ocean Acidification - Smithsonian website

The Ocean Portal Team Reviewed by Jennifer Bennett (NOAA). (2019, June 20). Ocean acidification. Retrieved February 18, 2021, from <https://ocean.si.edu/ocean-life/invertebrates/ocean-acidification>

[OCEAN ACIDIFICATION website](#)

## Elaborate

1. Review pH levels of Ocean before and after the KPg event.

Article: [Chicxulub-asteroid-ocean-acidification](#)

Joel, L. (2019, October 21). The dinosaur-killing asteroid acidified the ocean in a flash.

Retrieved February 18, 2021, from

<https://www.nytimes.com/2019/10/21/science/chicxulub-asteroid-ocean-acid.html?auth=login-google1tap&login=google1tap>

Questions:

[Questions: 'The Dinosaur-Killing Asteroid Acidified the Ocean in a Flash' Article](#)

Daniels, N. (2019, November 20). Lesson of the DAY: 'the Dinosaur-Killing Asteroid Acidified the Ocean in A FLASH'. Retrieved February 18, 2021, from

<https://www.nytimes.com/2019/11/20/learning/lesson-of-the-day-the-dinosaur-killing-asteroid-acidified-the-ocean-in-a-flash.html>

2. Acidification Interactive -

[Directions for Ocean Acidification Interactive](#)

[Ocean Acidification Model](#)

Understanding global change. (2021, January 26). Retrieved February 18, 2021, from

<https://www.biointeractive.org/classroom-resources/understanding-global-change>

3. [Understanding Global Change](#) - creating a concept map

## Evaluate

Complete a Claim, Evidence, Reasoning (Justification) activity.

### [CER Graphic Organizer](#)

Digital chalkboard. (n.d.). Retrieved February 21, 2021, from [https://www.mydigitalchalkboard.org/portal/default/Content/Viewer/Content;jsessionid=L4aR6nplmtOAEAlSb3zog\\*\\*?action=2](https://www.mydigitalchalkboard.org/portal/default/Content/Viewer/Content;jsessionid=L4aR6nplmtOAEAlSb3zog**?action=2)

### [CER Rubric](#)

Wisconsin department of Public Instruction. (n.d.). Retrieved February 18, 2021, from <https://dpi.wi.gov/sites/default/files/imce/science/CER%20Rubric.docx>

Statement: Human emissions of CO<sub>2</sub> are not only warming the planet but acidifying the oceans and today's acidification is happening at a rate and scale comparable to the asteroid triggered acid.

Claim: What is research that scientists could do now and what would be the evidence to prove the claim?