The Impression of Impact Craters

STUDENT NAME: .....

STUDENT ACTIVITY

SCIENTIFIC OCEAN DRILLING

Objective(s)/Outcome(s)

Students will be able to:

1. simulate and analyze impact structures using a physical model to collaborate and document observations.

2. apply observations their model to identify possible impact structure evidence preserved in the Yucatan peninsula landforms and use a digital model to make inferences about the magnitude of the Chicxulub impact event.

3. analyze and synthesize core data with initial model observations to compose a scientific explanation (justification) that supports the claim that the K-Pg Boundary is a result of the Chicxulub meteorite impact event.

Part A – Surface Model for Simulating Meteorite Impacts

Materials

- flour
- cocoa powder
- deep pie tins or baking pans
- marbles (or similar) of different sizes
- rulers
- spray bottle filled with water

Background A

The Earth has experienced numerous impacts from meteorites throughout its history, leaving behind impact structures that range in size from small craters to vast basins. These impacts have had a significant impact on the geological and biological evolution of our planet, including the extinction of the dinosaurs 66 million years ago. To better understand these events, scientists use models and simulations to recreate the impact process and analyze the resulting structures and materials. Evidence of impact events can not only be seen near where the meteorite struck the Earth but can also be found globally due to debris from the impact being carried through the atmosphere and eventually settling back to the ground.

Activity A

1. Drop the marble onto the model and observe the resulting impact structures.

2. Design a data table to record measurements and observations.

3. Record observations of the shape of the impact, as well as other changes that may have occurred.

4. Carefully remove the marble, and measure and record the diameter and depth of the resulting craters.

5. Once all your observations are recorded, gently shake the baking tray to smooth out the surface of the sediment.

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6. Use the spray bottle to evenly mist the surface of the sediment.

7. Repeat steps 1–3 two more times with marbles of different sizes.

8. Journal questions that could guide research about real impact structures.

Analysis A

1. Use observations of your experiment to describe what happens to Earth's surface during an impact event.

2. How does the size / mass of the meteorite affect the resulting crater? Use your data to support your claim.

3. What kind of evidence do you think scientists look for when studying past meteorite impacts?

4. What kind of short and long term effects do you think a meteorite impact can have on the environment and life on Earth?

Synthesis A

1. What evidence of a meteorite impact might we look for in the real world?

2. How might the impact structures you made relate to the impact associated with the extinction of the dinosaurs and the post-impact environmental changes?

Extensions A

1. Have students research and present on a relatively recent meteorite impact event. Encourage them to include information about the impact site, the resulting impact structure, and the environmental effects of the impact.

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Part B – The Ring of Cenotes

Materials B

- observations from Part A
- map of the Ring of Cenotes in the Yucatan peninsula
- computer with internet access
- copy of student handout

Background B

The Yucatan peninsula in Mexico is home to one of the most well-known impact structures on Earth, known as the Chicxulub crater. This structure was formed 66 million years ago when a massive meteorite collided with Earth, causing widespread destruction and contributing to the extinction of the dinosaurs. Despite being largely buried by sediment and vegetation, the Chicxulub impact structure is still visible in the form of various geological features, such as the circular ring of cenotes and the Chicxulub peak ring.

Activity B

1. Make observations and look for patterns using **maps showing the ring of cenotes** found on the Yucatan Peninsula.

2. Measure and record the size of the crater rim formed by the impact as evident in the ring of cenotes.

3. Using a computer, access the **Meteorite Launcher**, the online meteorite impact simulator.

    a. Modify the parameters of composition, diameter, speed, and impact angle to launch a meteorite in the simulation.

    b. Try out a few combinations of parameters to see how the impact site is affected.

    c. Then, try to recreate the Chicxulub impact by modifying and documenting parameters.

Analysis B

1. What patterns do you notice in the distribution of impact structures between the Surface Model for Meteorite Impacts activity and the Ring of Cenotes map? What might this tell us about the process of impact crater formation?

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2. Based on the data collected in this activity, what can we infer about the size and scale of the Chicxulub impact event and its effects on the Yucatan Peninsula?

Synthesis B

1. How do the observations and data collected in this activity support the hypothesis that the Chicxulub impact event was a major contributing factor to the mass extinction event at the Cretaceous-Paleogene boundary?

2. What other information would you want to know about the Chicxulub impact event to determine why it had such a profound and far-reaching effects across the Earth?

Extensions B

1. Explore the geoheritage of the Ring of Cenotes in the Yucatan Peninsula. Research the history and cultural significance of the sinkholes and caves, in addition to their geological formation. Why do you think the Ring of Cenotes should be preserved and protected as a geoheritage site?

2. What makes the Ring of Cenotes unique from features left at other impact sites? What impact has it had on the local ecosystem?

3. Explore the feedback loops that result from an impact event. Research how the release of energy during the impact can affect the Earth's atmosphere, hydrosphere, and biosphere.

Part C – Expedition 364 Core Data and Explanation

Materials C

- copy of station sandouts
- Oobservations and data from Parts A and B
- computer with internet access
- chart paper and markers (optional)

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Background C

The Chicxulub impact is widely believed to have contributed to the Cretaceous-Paleogene (K/Pg) extinction event, which occurred approximately 66 million years ago and marked the end of the Cretaceous period and the beginning of the Paleogene period. One of the key pieces of evidence supporting this hypothesis comes from the analysis of the 364 *JOIDES Resolution* core data.

In 2016, the International Ocean Discovery Program (IODP) conducted a drilling expedition called Expedition 364 aboard the *JOIDES Resolution* research vessel. The goal of the expedition was to collect rock samples from the Chicxulub Crater, which lies partly on land and partly beneath the Gulf of Mexico. The samples were obtained by drilling deep into the seafloor to collect core samples, which were then brought to the surface and analyzed by scientists. The 364 *JOIDES Resolution* core data provides a wealth of information about the impact event and its aftermath. The cores contain layers of sediment that were deposited in the aftermath of the impact, including a layer of ash and debris that was blasted into the atmosphere and eventually settled back down to Earth.

Activity C Workstations

1. Station 1: Chicxulub Core Poster

    a. Read over the **Blast from the Past poster** as well as the **flyer on core 40R-1** (automatic pdf download), to study the timeline of the Chicxulub impact event and specific layers of the core.

    b. Summarize information that supports the claim that the K-Pg Boundary is a result of the Chicxulub meteorite impact event.

    c. Identify any discrepancies or inconsistencies between their model and the *JOIDES Resolution* core data.

2. Station 2: Entire Core Overview

    a. View the **image of the entire core**.

    b. Repeat steps 1b–1c to analyze the image.

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3. Station 3: Core Descriptions

   a. View the **core description** scientists on board the *JOIDES Resolution* created for Core 40R (page 40). Compare this to other sections of the core taken from above (505–616 mbsf) and below (619–1335).

   b. Repeat steps 1b–1c to analyze the image.

4. Station 4: Profile of Iridium Core 40R-1

   a. Study the profile of iridium on the Data Handout.

   b. Repeat steps 1b–1c to analyze the image.

5. Station 5: Core 40R-1

   a. Study how each piece of data relates by viewing the series of images on the Core Handout.

   b. Repeat steps 1b–1c to analyze the image.

Synthesis C

a. Compose a Scientific Explanation: Use your findings from the workstations, as well as from Parts A and B, to compose a scientific explanation that supports the claim that the K-Pg Boundary is a result of the Chicxulub meteorite impact event.

Extensions C

1. Have students investigate the causes of other extinction events, such as the Permian-Triassic extinction, which is sometimes referred to as the "Great Dying" and is considered the largest mass extinction event in Earth's history. Encourage them to explore the evidence for different hypotheses about the causes of this event, such as massive volcanic eruptions, a meteorite impact, or some combination of factors.

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HANDOUT B

RING OF CENOTES

Patterns and Observations of Chicxulub Crater	
Size of Chicxulub Crater (km)	
Similarities of simulated craters to Chicxulub Crater	
Differences between simulated craters and Chicxulub Crater	

METEORITE LAUNCHER

Composition	Diameter	Speed	Impact Angle	Frequency and Observations

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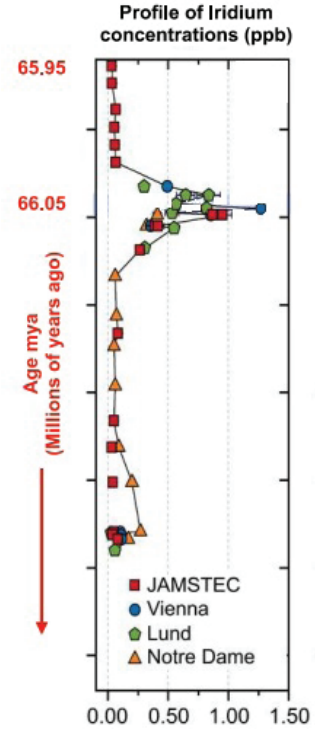
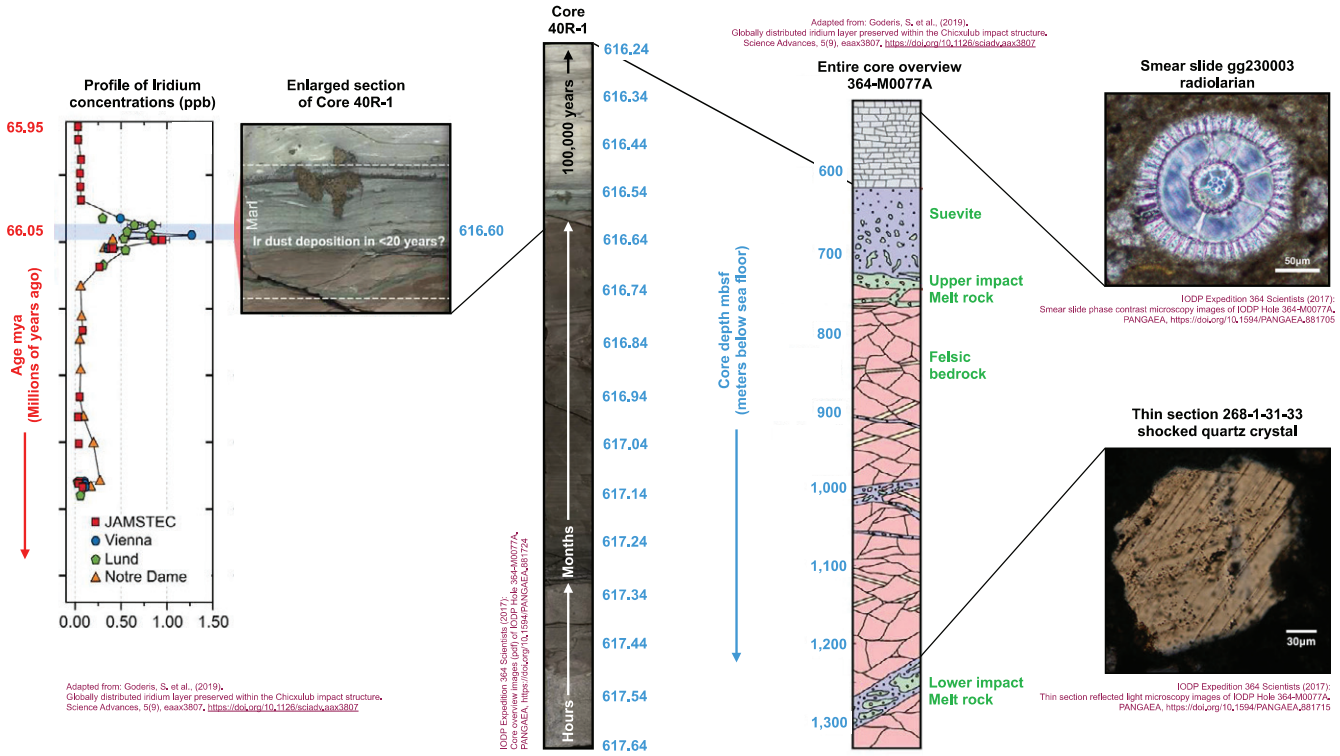
HANDOUTS C

STATION 4:



STATION 5: CORE HANDOUT



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WORKSTATIONS

Evidence	Supports the claim. What did you see? What are the relevant observations or data that support the claim? (Use some specific examples and data points)	
Claim	Answers the question. What claim can be made based on the evidence? Does the evidence support your prediction?	
Science Concepts	The science topics that have informed you. What scientific concepts are connected to the evidence and help explain the claim?	
Scientific Reasoning	Logic statements. How do the evidence and scientific concepts link to support the claim?	

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When writing your final scientific explanation, consider using some of the following sentence starters:

- The evidence I use to support _____ is _____.
- For example, you can see that _____.
- When looking at _____, you can tell that _____.
- If you measure _____, you will find that _____, which shows _____.
- The data regarding _____, shows _____.
- When observing _____, you can clearly see that _____.