Finding the Crater

OVERVIEW

This activity supports concepts covered in the BioInteractive short film *The Day the Mesozoic Died.* Students analyze geological evidence from 10 different sites around the world to predict the location of the asteroid impact that caused the mass extinction at the end of the Cretaceous Period. Students "visit" different K–T boundary sites, evaluate the evidence at each site, find these sites on a map, and predict where the crater is located. The activity tests a diverse set of skills, including mapping, mathematical scaling, and interpretation of mixed visual, graphic, and textual evidence.

Additional information related to pedagogy and implementation can be found on this resource's webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

- The analysis of fossils and elements found in rocks and sediments worldwide provides evidence for events that occurred millions of years ago.
- Sedimentary rock layers are formed by the deposition of material at Earth's surface; these materials may come from weathering and erosion, be transported by water, or "rain" down from the atmosphere.

STUDENT LEARNING TARGETS

- Interpret stratigraphic diagrams to identify the different types of rocks and deposits found in rock layers.
- Plot longitude and latitude on a world map.
- Make claims based on geological evidence.

PRIOR KNOWLEDGE

Students should be familiar with:

- the law of superposition
- interpreting longitude and latitude
- the geological timescale

MATERIALS

- the accompanying PowerPoint presentation
- 10 printed copies of the "World Map" PDF
- one printed copy of "K-T Boundary Sites" PDF
- colored pencils (e.g., red, orange, and yellow)

TEACHING TIPS

- You may want to watch the short film as a class and address any questions that students might have.
- Students can work independently or in small groups to examine the figures and answer the associated questions. Alternatively, you can project the figures and examine them as a class, then let students answer the questions independently.
- There have been some updates to the science in the film that you may want to clarify with students:
    - The film refers to the early Tertiary Period, which is now called the Paleogene Period. Similarly, the K–T boundary is now called the K–Pg boundary. This activity uses the phrase "K–T" throughout for consistency with the film.

  - The film gives the date of the asteroid impact as 65 million years ago. This date has since been revised to 66 million years ago.
- For more information on the film and an optional worksheet, refer to the accompanying film activity.

PROCEDURE

The following steps can be adapted to different audiences. Refer to the bullet points below for suggestions.

1. Show Act 1 of the film *The Day the Mesozoic Died* (0:00–15:26). Pause before the crater is revealed in Act 2.
2. Use the accompanying **PowerPoint presentation** to present the evidence that an asteroid impact would create nickel-rich spinels, spherules, tektites, and shocked quartz. Students should understand that this evidence may vary in quality and amount depending on how far from the impact it is found.
3. Divide the class into 10 teams of two to four students each.
4. Provide each team with printed copies of the **"World Map"** PDF. You may need to review the meaning and use of the latitude and longitude lines.
5. Print and arrange the 10 pages from the **"K–T Boundary Sites"** PDF at 10 "evidence stations" around the classroom. You may want to print the 10 pages in color and laminate them so that they can be reused.
6. Assign each team to a starting station and ask students to evaluate the evidence they find there. At each station, students should:
   - Use the longitude and latitude information to find the site on their map.
   - Decide whether the site is close to, at an intermediate distance from, or distant from the impact crater based on the evidence found at the site.
   - Indicate the site on their map using a specific symbol. (To make this activity accessible to colorblind students, use different shapes, not just different colors, to indicate distance. For example, you could use a red dot for close sites, an orange square for intermediate sites, and a yellow triangle for distant sites.)
   - Write the iridium concentration found at that site, if available.
7. Have students rotate through the stations, giving them two to three minutes to examine the evidence at each station. At their final station, students should complete the work for that station, then use all the evidence they've collected to propose a location for the crater.

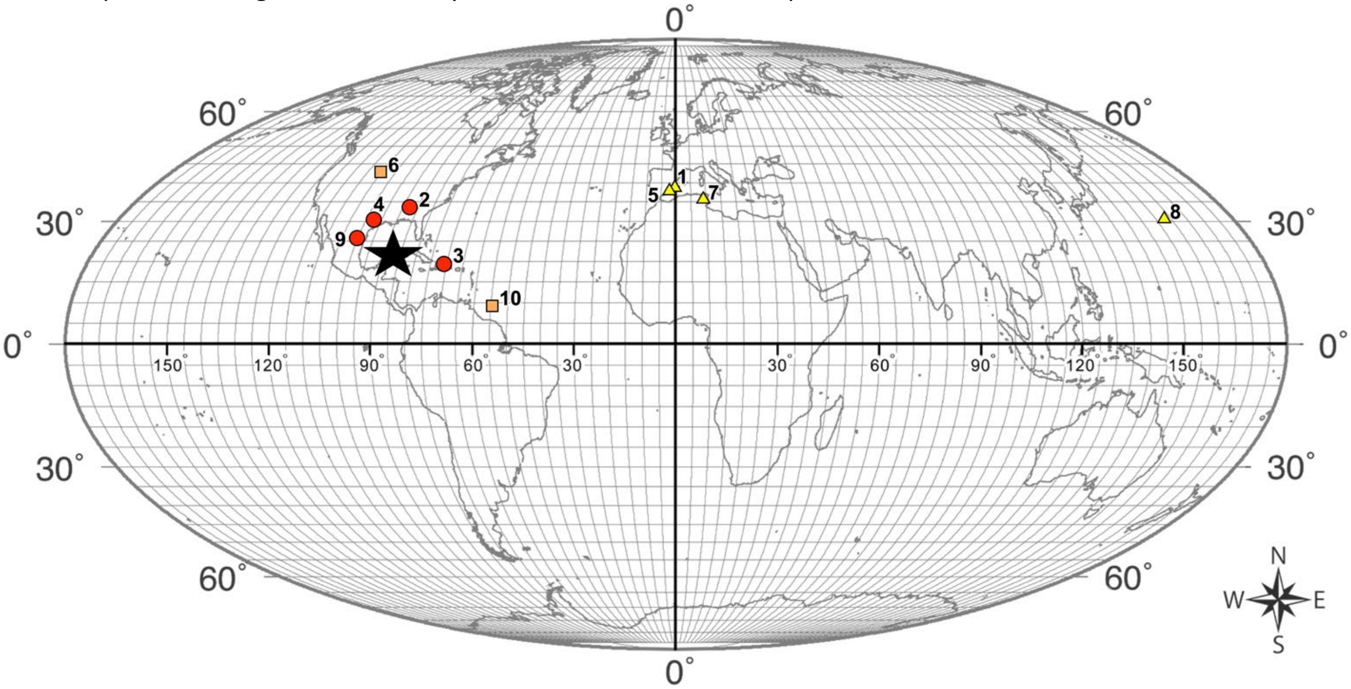
Suggestions for adapting this activity to different classroom settings and audiences are as follows:

- Slide 16 of the PowerPoint presentation indicates how to determine whether a particular site is close to, at an intermediate distance from, or distant from the site of the impact.
  - You may want to review this slide with students, then leave the slide on the screen as they carry out the activity. You could also print and distribute this slide as a handout.
  - For more advanced students, you may choose to skip this slide and let students come up with their own hypothesis for which sites are at which distances. For this approach, instruct students to make notes about the characteristics of the K–T event deposits at each site (i.e., type and size of debris, thickness of deposit). They can then determine which characteristics are variable among different deposits and what this variation might indicate about proximity to the crater.
- Instead of setting up evidence stations, you could provide each group of students with a copy of the entire "K–T Boundary Sites" document.
  - This option might work best if the students must come up with their own hypothesis for which sites are at which distance, as it will be easier for students to develop a hypothesis if they evaluate all the locations at once rather than from station to station.
- The activity can also be done as a whole-class exercise. In this case, you can print or project a larger version of the "World Map" PDF and display it on a wall. Each student team will then be responsible for examining the evidence at only *one* station and adding its symbol to the map.

ANSWER KEY

The mapped locations should look like the ones on the map below. In this example, red dots represent K–T sites close to the crater, orange squares represent sites at an intermediate distance, and yellow triangles represent sites that are far away. Numbers corresponding to the site numbers in the "K–T Boundary Sites" PDF are provided for reference.

The suspected location of the crater is indicated by a black star. As shown, the impact site is likely to be in North America, since that is where all the sites classified as close to the crater are located. Students may reach a different conclusion depending on their hypothesis as to which sites were close to the impact. Different answers are acceptable as long as students rely on evidence to make their predictions.



DISCUSSION POINTS

After completing the activity, consider discussing with students why they think the size and nature of the ejecta debris particles might differ depending on distance from the impact site. Students may realize:

- Larger particles ejected into the air generally will not travel as far as smaller particles. So, large rocks carried by giant waves generated by the impact will be found closer to the impact site.
- The amount of iridium found at K–T boundary sites worldwide does not correlate with the distance from the impact. This is because iridium was released from the asteroid as fine particles when the asteroid vaporized. These fine particles would have traveled to the atmosphere and been transported all over Earth.

REFERENCE

Schulte, Peter, Laia Alegret, Ignacio Arenillas, José A. Arz, Penny J. Barton, Paul R. Bown, Timothy J. Bralower, et al. "The Chicxulub Asteroid Impact and Mass Extinction at the Cretaceous-Paleogene Boundary." *Science* 327, 5970 (2010): 1214–1218. https://doi.org/10.1126/science.1177265.

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