Unit 2: Causes of Mass Extinction – Worksheet

The biosphere has been devastated at least five times in the last 500 million years. During those five major mass extinctions, extinction rates for marine animal species shot up dramatically. Seventy-five % or more of marine animal species have become extinct in less than a million years. The obvious questions are "how?" and "why?" The best fossil and rock records are those from the more recent major mass extinctions at the end of the Cretaceous and at the end of the Permian. Nonetheless, the scientific community is still arguing over the cause of each of these disasters. Immense volcanic eruptions (flood basalts) or massive extraterrestrial impacts may have caused the end-Permian and the end-Cretaceous mass extinctions.

Summary: Rather than reading through all of the evidence yourself and organizing it on your own, each of you should read part of it (it is already divided into articles A, B, C, and D) and work together with other students to summarize it. After you have done this, talk to students who have read different material and compare and contrast the information you have learned about flood basalt eruptions and massive impacts. Finally, re-group with yet other students to compare and contrast what you know about the end-Cretaceous and end-Permian extinctions.

Objectives: By the end of this exercise, you should be able to:

- Explain how the effects of either flood-basalt eruptions or meteor impacts could cause a mass extinction.
- Describe evidence for flood-basalt eruptions or massive impacts at the end of one of the ancient mass extinctions.
- Describe the probable effects of a flood-basalt eruption or a massive impact.
- Compare and contrast the end-Permian and end-Cretaceous ancient mass extinctions.

Procedure: A day or more before the exercise, your instructor will divide students into four equal-sized reading groups. Skim this handout before you read your assigned article. Think about answers to the questions for your group for step 1 (next page) before you discuss them with other students in class.

0. Read the assigned article before the next class:

   Group A: End-Cretaceous flood basalts

   Group B: End-Permian flood basalts

   Group C: End-Cretaceous impact

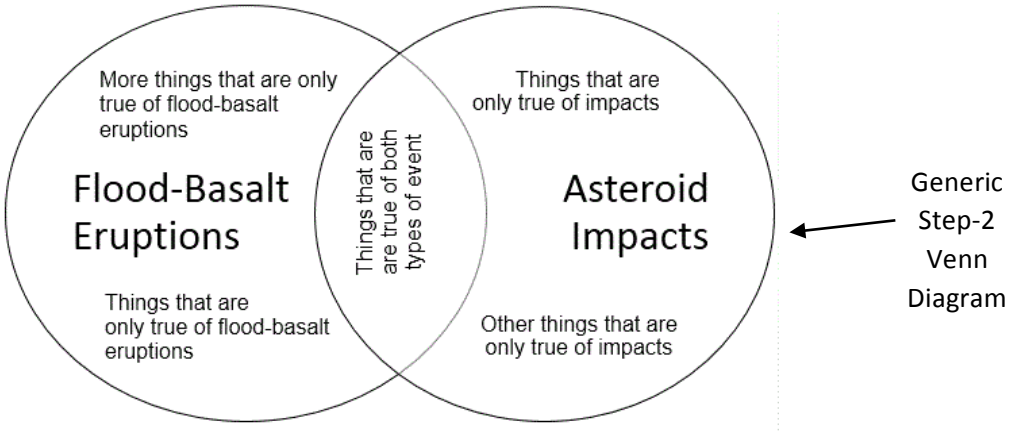
   Group D: End-Permian potential impacts

- There is also a study guide (just a couple of pages of definitions of vocabulary).
- Your instructor will also have you take a quiz that is appropriate to your assigned reading. Your quiz score indicates whether you have done the reading carefully. You will be assigned to a SuperTeam (discussion group) with students who have a similar level of preparedness.

In-Class Exercise Summary

Make sure to get to class on time and bring your article (or notes), this handout, and a pen or pencil. Your instructor will assign you to a SuperTeam, which should have at least one student from each reading group: A, B, C, & D. Since each of you has read a different article, you all have different information to discuss with the group, and you will work together to understand the similarities and differences between these theories and extinction events. You will work in pairs or in groups of three with other members of your SuperTeam for steps 1 and 2, and the whole team for step 3.

1. First, get in a group with the member(s) of the SuperTeam who read about the same kind of cause (flood-basalt eruptions or massive impacts) as you but a different mass extinction (end-Permian or Cretaceous). Answer the questions on page 3 relevant to your groups & take notes: **10 min.**
    - Questions about Flood Basalts: only the students from grp A & grp B
    - Questions about Massive Impacts: only the students from grp C & grp D
2. When your instructor calls time, form new groups, this time with someone who read about the same extinction as you, but a different cause (End-Cretaceous: students from groups A & C, End-Permian from groups B & D). Together, compare and contrast the proposed causes, effects leading to extinction, and available evidence for flood-basalt eruptions and massive impacts. Guiding questions are on p. 4. In your notebook or on page 5, use a Venn Diagram to organize the discussion – **10 min.**



3. When your instructor calls time, your whole SuperTeam will work together to create a Venn diagram (p. 6) to compare and contrast the mass extinctions at the end of the Permian and the end of the Cretaceous (more guiding questions are on p. 4). What do we know about each of those extinctions? What caused each one (the same thing or different ones?)? How do we know? – **15 min.**
4. Finally, the instructor will ask at least one group to summarize their diagrams from step 3 (compare and contrast the end-Permian and end-Cretaceous extinctions). Did you all come to the same conclusion?

1) Mechanisms of Extinction – 10 minutes – only answer about the questions relevant to your article

Flood-basalt eruptions for the people from groups A & B

How do flood-basalt eruptions differ from other volcanic eruptions?

How could flood-basalt eruptions lead to global extinctions of whole families of organisms on land and in the sea?

What evidence tells about the timing and extent of these particular eruptions?

Massive Impacts for the people from groups C & D

How could asteroid impact lead to global extinctions of whole families of organisms on land and in the sea?

Are there alternative explanations for the formation of either of these sites?

What is the evidence for impact at each site? How convincing is it?

2) Potential Causes (Permian or Cretaceous) – 10 minutes – Questions to Guide Discussion

Review: Take turns familiarizing each other with the different theories for the cause of your extinction (either Permian or Cretaceous). Your answers to the questions on the previous page may help.

What is a flood-basalt eruption or a massive impact? Why do they happen? How often? What effects do they have on Earth's surface, on Earth's atmosphere, on the biosphere, and on water resources? How do we know whether they have happened before and when and where?

Compare and Contrast: Here is where you brainstorm together and choose items to put in the three different compartments of the Potential Causes Venn diagram on the next page. How are the major theories for your mass extinction (whether it be the end-Permian or the end-Cretaceous) similar and how are they different?

What do the proposed **causes**, flood-basalt eruptions and massive impacts themselves, have in common? How are they different? Think about how often these events occur, what causes them to happen, what kind of material is brought to Earth's surface during the event and from where, how long they last, how much energy they release and how fast, etc.

What do the **effects** of flood-basalt eruptions have in common with those of massive impacts? How are they different? What are their effects at the surface of Earth/the atmosphere/water/biosphere? How long would those effects have lasted?

How does the **evidence** for a flood-basalt eruption resemble that for a massive impact? How are they different? Are both theories for the cause of your mass extinction equally compelling?

3) Ancient Mass Extinctions – 15 minutes – Questions to Guide Discussion

Review: Take turns telling the other pair of people about your mass extinction (end-Permian for one pair, end-Cretaceous for the other). How severe an extinction was it (in terms of the percentage of species that died out)? How long did it take? Was there evidence for one or more series of flood basalt eruptions? Where and when? How about for one or more massive impacts? How confident are you in the quality of that evidence and of the interpretation of it? Were these two extinctions caused by the same type of event? How sure can we be of that?

Compare and Contrast: In your discussion of the questions above, you probably noticed some similarities and differences between the end-Permian and end-Cretaceous mass extinctions. You should record these on the Ancient Mass Extinctions Venn diagram (page after next).

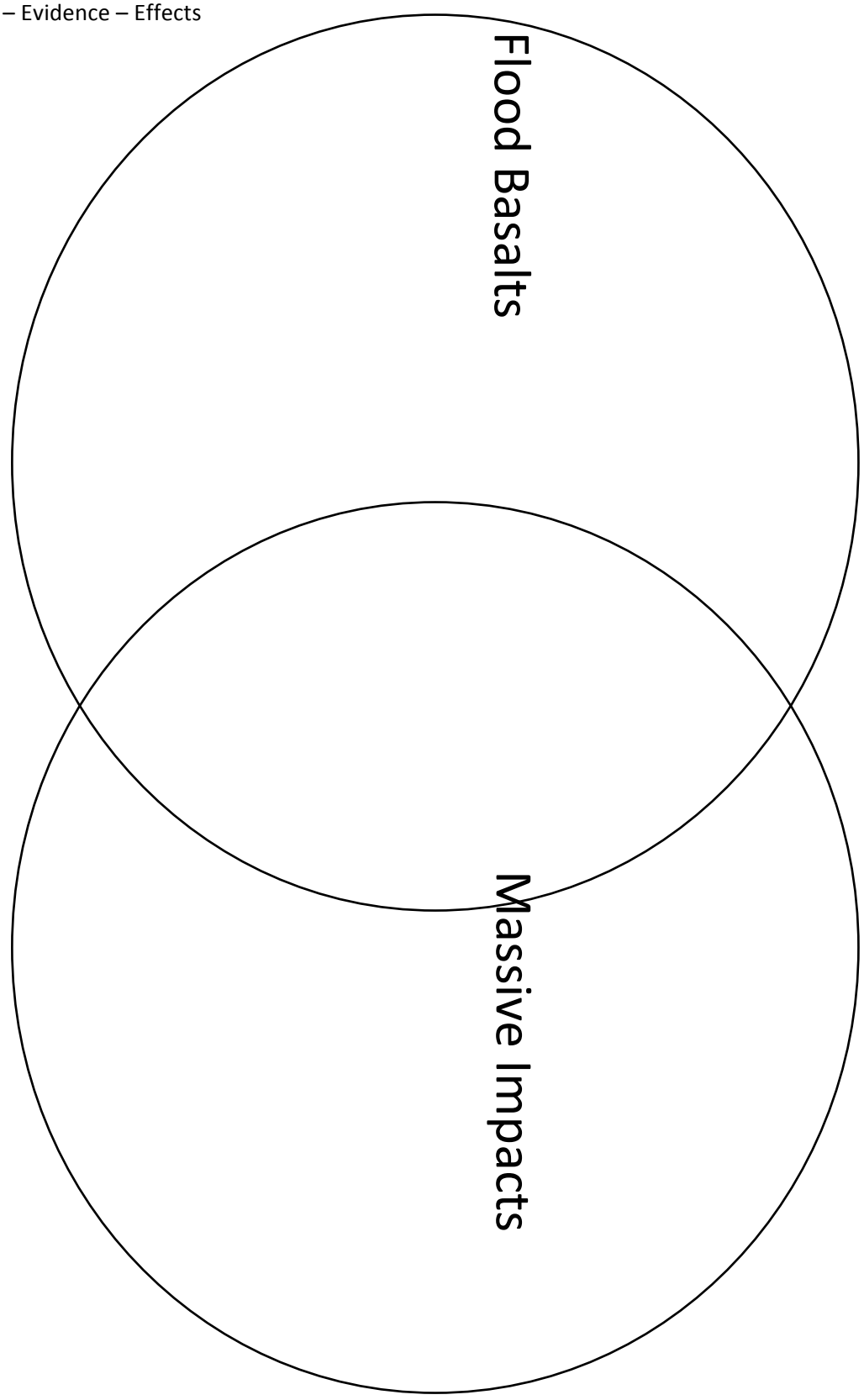
What do you think caused each one? Your team may not be able to agree. Do not worry, the scientific community cannot, either. Welcome to the club. In what ways are the two extinctions likely to have been similar or different in terms of the atmosphere/oceans/food-chain, etc.?

Were the extinctions similar or different in severity, duration, etc.?

Is there similar evidence to explain what happened in both cases? In what ways does the evidence from 66-million-year-old rocks (end-Cretaceous) different from that in 252-million-year-old rocks (end-Permian)?

2) Potential Causes (Permian or Cretaceous)

Causes – Evidence – Effects



3) Ancient Mass Extinctions

Causes – Evidence – Effects