



# Cold Seeps: Methane Ice Worms Student Worksheet

## Introduction

**Cold seeps** are places throughout the ocean where hydrogen sulfide, methane, and other hydrocarbon-rich fluids and/or gasses escape from cracks in the ocean floor. These chemicals create a toxic environment in the surrounding waters, yet, ocean explorers regularly observe dense and unique biological communities.

In this lesson, you will explore and answer a question based on a phenomenon you will see by analyzing the evidence and reasoning to support a hypothesis (claim).

## Experience the Phenomenon

Your teacher will project an image for you to observe. Then follow the directions for 1 and 2.

1. Write down at least 2-3 observations and 2-3 questions you have of this image and share with your partner/group.

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2. After discussing with your group, share 1-2 observations and questions on a class whiteboard or other shared space your teacher has provided.

## Investigate

Investigate the phenomenon by analyzing evidence that was published by scientists between the discovery of the methane ice worms in 1997 and 2022.

Immediately following the discovery and in the years since that time, scientists have investigated this question:

***How do methane ice worms obtain organic compounds and energy while living on methane hydrate?***

When scientists have an unanswered question like this, they often develop hypotheses that can be tested by collecting new evidence. A **hypothesis** is a plausible explanation that answers the question about a phenomenon and predicts a particular and stable outcome. Scientists have focused on **two main components** of the hydrate, where the ice worms were discovered methane and hydrogen sulfide. For each of these compounds, there were **three hypotheses** to be tested.

### HYPOTHESES (CLAIMS) ABOUT THE METHANE ICE WORM

Methane	Hydrogen sulfide
1) The worms metabolize methane directly.	4) The worms metabolize hydrogen sulfide directly.
2) The worms consume bacteria that metabolize methane.	5) The worms consume bacteria that metabolize hydrogen sulfide.
3) The worms rely on symbiotic bacteria that metabolize methane.	6) The worms rely on symbiotic bacteria that metabolize hydrogen sulfide.





## METHANE ICE WORM EVIDENCE AND REASONING CARD SORT

### Task Overview

Working in a small group of 3-5 individuals, use the various pieces of evidence scientists have collected since 1997 to construct an argument about which of the **hypotheses (claims)** stated in the table above is best supported. Your set of cards contains **15 Evidence cards** that describe observations or data collected by scientists who have studied the methane ice worms, **15 Reasoning cards** that provide scientific background knowledge needed to interpret the evidence, and **2 Understanding the Evidence cards** for reference.

### Instructions:

- Read each evidence and reasoning card, then match each evidence card with a corresponding reasoning card.
- Select a 2-3 pieces of evidence (along with the corresponding reasoning cards) that you think are the most relevant to evaluating the hypotheses about the methane ice worms.
- Determine which hypothesis (claim) is best supported by the evidence and develop an argument about how that claim is supported by the evidence and reasoning you have selected.

### As you conduct the card sort, THINK about these questions.

- Why do you think that piece of evidence goes with that reasoning?
- What does that evidence and reasoning tell you? Why is it important?
- How does that evidence and reasoning help you evaluate the hypothesis you chose?

## Put the Pieces Together

After your group has completed the card sort, work together to come to a consensus on the best hypothesis and supporting evidence and reasoning to answer the question, “**How do methane ice worms obtain organic compounds and energy while living on methane hydrate?**” Use questions 1-4 to help guide you.

1. Are there any hypotheses that we can eliminate?
2. Did your group come to consensus regarding any remaining hypotheses?
3. Which pieces of evidence seem to be most important? Is there consensus within your group about this?
4. What changes would you make to your initial argument after seeing the arguments from other group members?

## Assessment

After the final class discussion, independently construct a final written argument that answers, “**How do methane ice worms obtain organic compounds and energy while living on methane hydrate?**”

The argument should include the following:

- The hypothesis you have selected.
- The specific evidence and reasoning you have selected.
- A rationale explaining how your selected evidence and reasoning supports your selected hypothesis.
- A brief reflection of how your thinking was changed or reinforced by your group and class discussions.