

## Natural Records of Change: Working with Indirect Evidence of Past Climates

**Unit: Little Ice Age**  
**Lesson: 2**

### Materials & Preparation

#### Time:

- Preparation: 10 minutes
- Teaching: 45 minutes

#### Materials for the Teacher:

- Overhead projector
- Overhead transparency of p.4 of this lesson
- Chalk or white board
- Examples of tree rings or fossils to show to the class (optional)

#### Materials for Students:

- Colored pencils, markers, or crayons (6 colors per pair of students)
- Pencil
- Paper
- Student Page 1 and 2

#### National Science Standards

- Earth and Space Science: Content Standard D
- Science in Personal and Social Perspectives: Content Standard F
- History and Nature of Science: Content Standard G

#### Colorado Science Standards

- Science: 4.2, 5d, 6d

#### Learning Goals

##### *Students will*

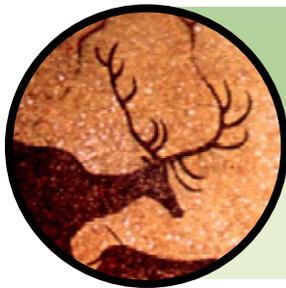
- Learn that evidence of climate change is found in the natural world (indirect evidence) and human observations (direct evidence).
- Learn that indirect evidence can be interpreted if you know how the natural system that generated the indirect evidence works.
- Scientists study how natural systems are influenced in the modern world in order to interpret indirect evidence and understand how they were influenced by past climate change.
- Understand that scientists use data from many sources to understand past climates and climate change.

#### What Students Do in this Lesson

Students play a dice game to explore the differences between direct and indirect evidence. Student pairs roll dice and record the numbers rolled as a series of colors instead of numbers. Other pairs of students try to crack the color code to figure out the sequence of numbers rolled. In this way, students gain an understanding of how indirect evidence of climate change can be interpreted. In conclusion, the class discusses the various records made by humans and indirect evidence found in nature that can be studied to understand how climate has varied through time.

#### Key Concepts

- Scientists collect data from many sources to identify, understand, and interpret past changes in Earth's climate.
- Natural records of climate change, such as tree rings, ice cores, pollen and ocean sediments offer indirect evidence of climate change. They require knowledge of how the natural recorder works.
- Records made by humans, such as artwork, harvest records, and accounts of changing seasons, are more direct, but can be incomplete.



## Natural Records of Change: Working with Indirect Evidence of Past Climates

### Advanced Preparation

- Read and review the lesson plans and associated science background information provided.
- Familiarize yourself with the different types of climate recorders shown on the overhead (p.4).

### Introducing the Lesson

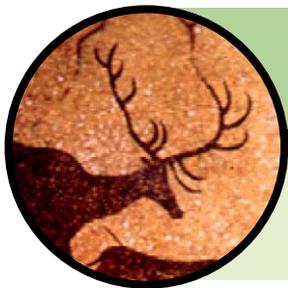
- Explain that clues to how the climate has changed exist in the natural world in tree rings, Arctic and Antarctic ice, and layers of sediments on the seafloor and lake bottoms. Discuss why these data are indirect evidence of past climate.
- Explain to students that in this activity they will assume the role of scientists viewing and interpreting data. They will record indirect evidence of events that happened. They will learn what is involved in accurately interpreting indirect evidence.
- Give students an overview of the activity: First they will, in pairs, generate the indirect evidence that will be interpreted by another group.

### Facilitating the Lesson

- Divide students into pairs and provide each pair with a copy of Student Page 1 (Direct Evidence Secret Key) and Student Page 2 (Indirect Evidence Record).
- Provide each student pair with one die. Instruct them to roll the die and record the series of numbers they rolled in order on the Record of Direct Evidence (Student Page 1, Step #1). Have students repeat this process for 20 rolls of the die.
- Instruct students to choose a color to represent each number (1-6) on their Secret Key (Student Page 1, Step #2) and mark that color in the box next to the number. Tell students that the color key should be kept secret from other student pairs.
- Then instruct students to record the colors that correspond to the sequence of numbers rolled (as they chose in their Key) on the Indirect Evidence Record (Student Page 2, Step #3). Do not write the numbers on the Indirect Evidence Record (Student Page 2)!
- Have two pairs join together making a group of four. Tell the pairs of students that their goal is to decode each other's keys without speaking a word or looking at the Secret Key (Student Page 1).
- To figure out which color corresponds to which number, one pair watches (and takes notes) while the other pair continues to roll the die and place a color along their remaining squares in the Indirect Evidence Record (Student Page 2, Step #4).
- Once one pair has the key decoded, and has identified which numbers were rolled in order on the Indirect Evidence Record (Step #5), allow them to check the key. Then the pairs switch roles.

### Summarizing and Reflecting

- Tell students that the natural world leaves indirect evidence of climate change. Scientists study how things in the natural world are affected by changes in temperature so that they can decode indirect evidence left behind by these natural things. Show the class the overhead transparency that highlights various types of evidence and discuss the many different types of indirect evidence that scientists investigate to understand past climate. Then discuss the direct evidence that they use (records made by humans). Discuss the benefits and limitations of each.



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### Science Background Information

Paleoclimatology: The science of reconstructing climate history.

Scientists interested in climate change do not have methods for directly measuring ancient conditions. Thus, they collect indirect evidence of climate change, known as “proxy” data. Each source of data may respond to different conditions in the local and global environment. Humans recorded observations of weather because it has been very important throughout our history. By combining data from various historical sources, scientists develop a broad understanding of climate change over hundreds of years for specific regions of the world. Nature and humans have created records of climate change. For example:

#### Nature's records of climate change (proxy data):

- Tree rings
- Location (elevation and latitude) of environmentally sensitive plant and animal life
- Ice layers in glaciers
- Pollen
- Ocean and lake sediments

#### Human records of climate change:

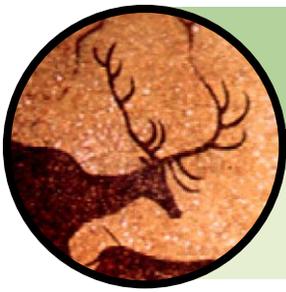
- Records of harvest production
- Records of the cost of basic foodstuffs
- Artistic renderings of the environment
- Photographs
- Records of annual social events based on natural phenomena (such as harvest celebrations)
- Records of the timing of tree flowering and lake freezing

### Extensions

- Have students develop their own secret code for others to decode.

### Additional Resources

- What is Paleoclimatology?  
<http://www.ngdc.noaa.gov/paleo/primer.html>
- Influence of Climate Change on Human Society  
<http://www2.sunysuffolk.edu/mandias/lia/index.html>
- Importance of art to science  
<http://www.mit.edu:8001/people/davis/EncycEnv.html>
- Kuntstshistoridche Museum, houses several Brueghel paintings  
<http://www.khm.at/homeE3.html>.



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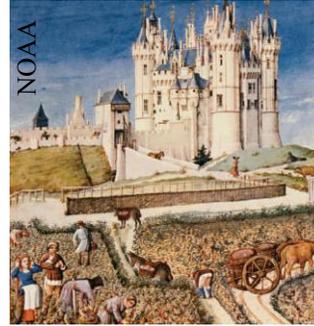


**Tree rings:**  
Yearly records  
of variability in  
temperature and  
water

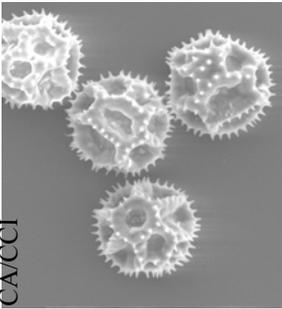


When seasons  
change:  
Records of  
when trees  
flower and  
when lakes  
freeze

**Ice Cores:**  
Yearly variations  
in volcanic ash,  
temperature  
as recorded by  
isotope ratios



**Food!**  
Records of harvest  
production,  
celebrations, and  
the cost of food



**Pollen:**  
Indicates what plants  
grew where. If we  
know their growing  
conditions, we can  
interpret climate of  
the area.

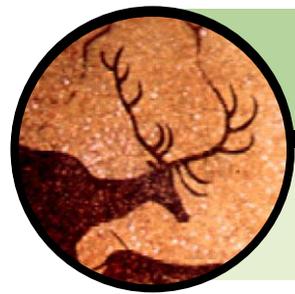


**Ocean and lake  
sediments:**  
Records of  
plankton,  
isotopes, color,  
decomposition,  
etc.



**Artwork:**  
Paintings and photographs of  
people and places provide re-  
cords of climate.

Note: Use for summarizing. Print on transparency and share with overhead.



Working with  
Indirect Evidence: I

Name \_\_\_\_\_

Date \_\_\_\_\_ Class \_\_\_\_\_

**Direct Evidence Secret Key (Don't let other groups see this page!)**

Data collected by (names): \_\_\_\_\_

1. Roll the die 20 times. Record the **number** of each roll on the timeline below. Your first roll is marked next to "start".

**Record of Direct Evidence (numbers only!)**

Start

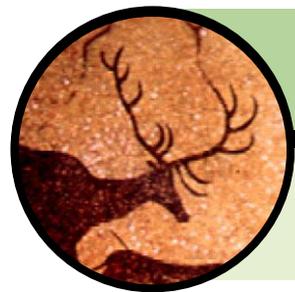
Finish

<input type="checkbox"/>																			
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2. Decide which colors you would like to represent each number of the die. Create a key with the colors and numbers below.

**Key:**

Number	Color
1 	<input type="checkbox"/>
2 	<input type="checkbox"/>
3 	<input type="checkbox"/>
4 	<input type="checkbox"/>
5 	<input type="checkbox"/>
6 	<input type="checkbox"/>



## Working with Indirect Evidence: 2

Name \_\_\_\_\_  
Date \_\_\_\_\_ Class \_\_\_\_\_

### The Indirect Evidence Record

Data collected by (names): \_\_\_\_\_

3. Color the boxes below based on the number of each roll in your Record of Direct Evidence and the key on the other page. For example, if blue is the color you chose for the number two and you roll a two, you would color the square blue. Your first roll is the box next to "start". **DO NOT WRITE THE NUMBER!**

### Record of Indirect Evidence (Colors only!)

Start

Finish

<input type="checkbox"/>																			
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4. **Decoding the key!** Your teacher will assign you to work with another pair of students. Let the other pair of students watch as you roll the die and color in the boxes below. How many rolls of the die will it take for them to crack your color code? Keep rolling the die and filling in colors until they think they have it figured out. Don't tell them what colors are used for each number.

<input type="checkbox"/>														
<input type="checkbox"/>														
<input type="checkbox"/>														

### 5. The secret code is...

To the other pair of students: Have you cracked the code of these data recorders? If so, fill out below what you think the **numbers** are along the timeline that are represented by each color. Then, compare with your classmates' key.

Start

Finish

<input type="checkbox"/>																			
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