



Where Have All the Glaciers Gone?

Unit: Little Ice Age
Lesson: 4

Materials & Preparation

Time:

- Preparation: 20 minutes
- Teaching: 45 minutes

Materials for the Teacher:

- Overhead projector
- Overhead Transparencies of: Rhone Glacier images, Boulder Glacier Images, and Venn diagram
- (recommended) Internet access

Materials for Student Pairs:

- Rhone Glacier Images
- Venn Diagram
- (recommended) Internet access for pairs/small groups

Materials for Individual Students:

- Boulder Glacier images
- Pencil

National Science Standards

- Science as Inquiry: Content Standard A
- 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: 1, 4.2b, 4.4c, 5d, 6c

Learning Goals

Students will

- Understand the difference between weather and climate.
- Examine and interpret evidence of climate change.
- Understand that scientists use multiple sources of data to interpret changes in the climate.
- Understand that natural and human records of climate change exist.
- Understand that scientific research takes place in the field and in the laboratory.
- Collect, record, interpret, and communicate scientific information regarding climate change.
- Use scientific reasoning to explain changes the environment and climate over time.

What Students Do in this Lesson

In this lesson, students compare and contrast past and present images of the Rhone Glacier, Switzerland to identify changes in the environment and climate over the past century. Students examine images of glaciers to develop an understanding of glaciers respond to climate change. They record, discuss, and interpret their observations. They consider explanations for changes in the size and position of glaciers. Following their work with images of the Swiss glacier, students apply their knowledge to the Boulder Glacier located in Montana. They understand that the melting or retreat of glaciers occurs simultaneously on different continents around the world and thus, represent evidence of global climate change.

Key Concepts

- The position and size of glaciers changes.
- 100 years ago the Rhone and Boulder glaciers were much larger.
- Natural and human made landmarks allow one to judge the change in size and extent of the glacier over time.
- Rock deposits (moraines) created by melting of glaciers indicate the past extent of the ice.
- Historical and present-day images are used to understand climate change.
- Glaciers around the world are melting indicating that Earth's climate is warming.



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Advanced Preparation

- Read and review the lesson plan and the science background information.
- Make photocopies of the teacher and student on overhead transparencies
- Make copies of student pages, one per student.
- Gather additional images of glaciers or bookmark appropriate Internet sites.

Introducing the Lesson

- Introduce students to a map of Switzerland and the small mountain town of Gletsch, below the Furka Pass.
Maps of Switzerland
 - <http://www.lonelyplanet.com/mapshells/europe/switzerland/switzerland.htm>
 - <http://flagspot.net/flags/geo-ch.html>
- Explain to students that if they were to visit Gletsch, Switzerland, they would see very steep mountains, a small rural town, and a narrow winding road through the mountains.
- Show students images of the Swiss Alps and indicate features of the landscape including the mountain tops, snow fields, and glaciers.
- Ask students if they know what a glacier is and how it forms. (Glaciers are large, flowing bodies of ice that form on land during long periods of cool conditions when precipitation falls as snow and accumulates faster than it melts.)
- Explain that students will receive two images of the Rhone Glacier, one from 1906 and one from 2003.
- Ask students to make careful observations of each image and model how to use the Venn diagram to compare and contrast the images.
- Explain that teams will share their observations with the class
- The class will brainstorm reasons for differences in the images.

Facilitating the Lesson

1. Pair students and distribute to each team a set of images of the Rhone glacier and Venn diagram.
2. Allow students time to examine the images and complete the Venn diagram recording similarities and difference between the past and present images of the glacier.
3. Circulate among the students and prompt them to make careful observations and record specific details on the Venn diagram.

Summarizing and Reflecting

- Bring the class back together.
- Have each team share one or more observations they made about the two images of the Rhone Glacier.
- Record team observations on an overhead copy of the Venn diagram.
- Next, ask students to brainstorm explanations for the differences in the images.
- Record their hypothesis on a separate transparency, on chart paper, or on the board.
- Review the Key Concepts list as needed.
- Following the discussion and brainstorming of reasons for changes in the extent and position of the Rhone Glacier. Ask students to identify one or two of the most likely reasons for changes in the size and position of the glacier.
- Point out to students that glaciers respond to long term changes in climate.



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Extensions or Homework

- Introduce the Boulder Glacier images as an additional class assignment or as homework.
- Have students apply their knowledge and experience with the Rhone Glacier to their study of the Boulder Glacier.

Additional Extensions

- Map the recession of a specific glacier. Use aerial photographs and topographic maps to delineate the present and past positions of glaciers.

Science Background Information

How do glaciers respond to changes in the climate?

Glaciers respond to long term changes in the Earth's energy budget, the amount of energy that reaches Earth from the Sun. If the average temperature on Earth increases, glaciers melt. They appear to retreat or move up valley. The opposite is true as well. Small decreases in the average annual temperature cause glaciers to increase in size and spread over the land. In the last several hundred years, most glaciers in the world have retreated which suggests an increase in average annual global temperature.

How do we know glaciers move?

The location of moraines, sinuous hills of rock, deposited when a glacier remains in one location, provide information about the past extent of glaciers. A series of moraines are created as glaciers melt. The furthest moraine from the present position of the ice indicates the greatest extent of the ice. As glaciers expand, they can destroy trees which are preserved in the ice. Melting of glaciers may reveal ancient plant life. Scientists can determine when the plant died by using a carbon dating processes (known as C-14 dating). Also, sample of tree rings taken from the tree may be matched to those in a database to identify period of time when the climate was suitable for plant growth.



Additional Resources

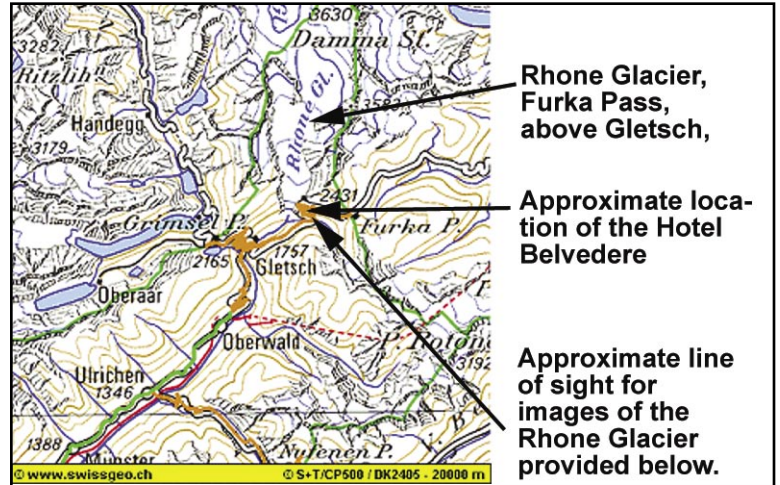
- What is Paleoclimatology?
<http://www.ngdc.noaa.gov/paleo/primer.html>
- Influence of Climate Change on Human Society
<http://www2.sunysuffolk.edu/mandias/lia/index.html>
- Importance of art to science
<http://www.mit.edu:8001/people/davis/EncycEnv.html>
- Dating Violins
http://www.knoxnews.com/kns/local_news/article/0,1406,KNS_347_2259772,00.html
- Kuntsthistoridche Museum, houses several Brueghel paintings
<http://www.khm.at/homeE3.html>.



Where Have All the Glaciers Gone?

Rhone Glacier information for Student Page #1

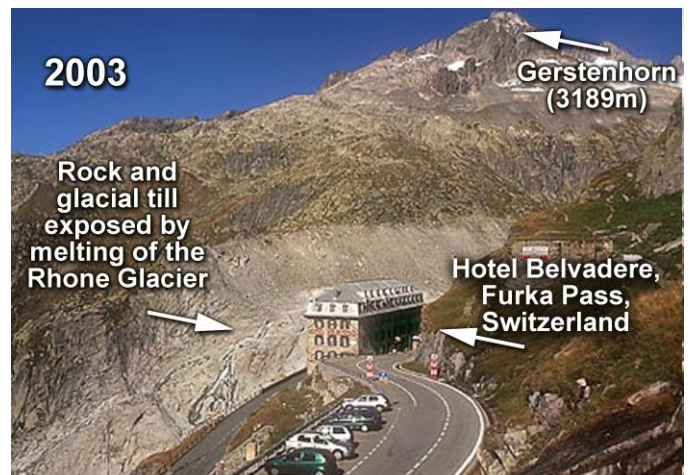
- Map at right:
Topographic map of the region surrounding the Rhone Glacier.



- Painting at right:
Date: Approximately 1906
Location: Furka Pass above Gletsch, Switzerland
Description: This image shows the Rhone glacier behind the Hotel Belvedere in about the year 1906. The glacier is located near the town of Gletsch and the Furka Pass in northeastern Switzerland. The glacier has experienced extensive melting over the past century.
Artist: Unknown



- Photograph at right:
Date: 2003
Location: Furka Pass above Gletsch, Switzerland
Description: By 2003 the Rhone glacier has melted exposing the valley floor scrapped free of soil leaving a carved the U-shaped valley formerly filled with ice during a cooler period in Earth's history. Recent increases in mean annual global temperature are responsible for the disappearance of glaciers around the world.





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Boulder Glacier information for Student Page #3

Location: Glacier National Park, Montana, USA

Description: The two photographs of the Boulder Glacier in Glacier National Park, Montana show that glaciers respond to changes in climate that occur within the span of a lifetime. In a 56 year period, the position and extent of the glacier changed drastically. The glacier has virtually melted and vegetation has grown up in its place.



1932
Boulder Glacier
Glacier National Park
Montana
By George Grant



1988
Boulder Glacier
Glacier National Park
Montana
By Jerry DeSanto



Page #1: Where Have
All the Glaciers Gone?

Name _____
Date _____ Class _____

Directions

- Compare and contrast the two images below.
- What features of the landscape remain unchanged?
- What changes occurred in the landscape between 1906 and 2003
- **Use the Venn diagram to record your observations.**



The Rhone Glacier and the Hotel Belvedere in **1906**



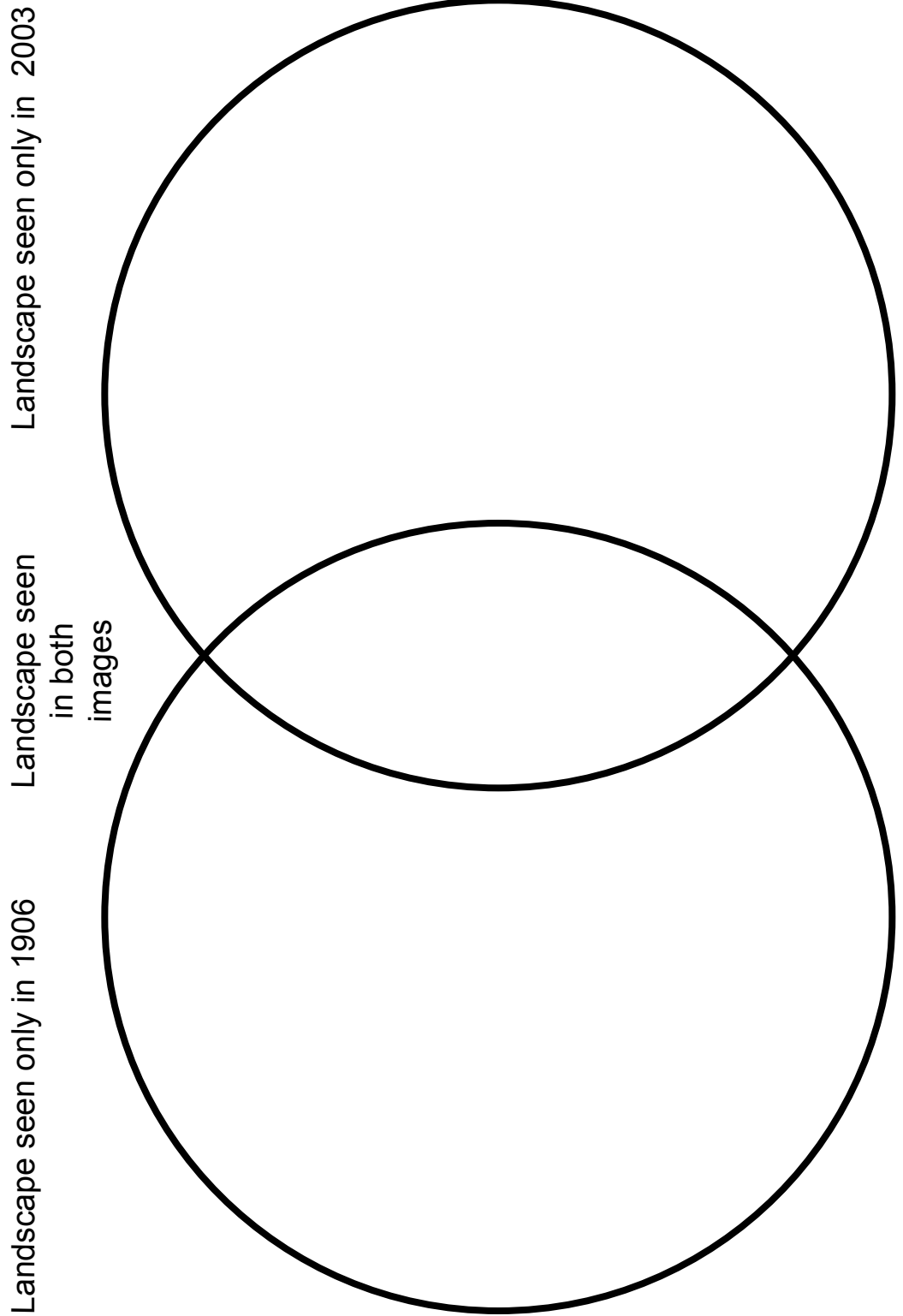
The Rhone Glacier and the Hotel Belvedere in **2003**



Page #2: *Where Have
All the Glaciers Gone?*

Name _____
Date _____ Class _____

- Directions**
- Use the 1906 and 2003 pictures of the Rhone Glacier to complete this Venn diagram.





Page #3: Where Have All the Glaciers Gone?

Name _____
Date _____ Class _____

Directions

- Compare and contrast the two images of the Boulder Glacier shown below.
- Create your own graphic organizer and use it to list the similarities and differences between the images.

Answer the following questions on a separate sheet of lined paper

- What evidence in the photographs indicates that the images are from the same location?
- How much time has passed between the taking of the first and the second photograph? Show your mathematical calculation.
- What changes occurred to the landscape between 1932 and 1988? Be specific.
- Imagine that you took ONE of the two photographs. Write a brief paragraph explaining how you spent the day vacationing in the area.



1932

The Boulder Glacier,
Glacier National Park, Montana



1988

The Boulder Glacier,
Glacier National Park, Montana