DENALI: THE HIGH ONE

Geology of the Mountain

Teacher Guide

(NPS Photo Tim Rains)

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Denali: The High One

Lesson Overview

The landscape and geology of Denali National Park and Preserve is a fascinating subject for investigation. In this lesson, students are introduced to the mountain from which the park gets its name, that is, Denali which means the "High One" in the native Athabascan language. Students follow park geologist Sue on a climb to the summit of Denali. Along the way we compare the elevation of Denali to other mountains in the lower 48 states and to Mt. Everest. We explore how Denali's elevation affects weather and climate by creating a rain shadow effect. Then we investigate how mountains are built and why this particular mountain is so high. Finally we discover how snow turns into glaciers, and celebrate climbing to the top of the tallest mountain in North America!

Lesson Objectives:

Students will be able to:

1. Use a chart to compare the elevations of mountains in the U.S. to the elevation of Denali.
2. Explain the difference between elevation and relief and how this impacts our perception of mountain height.
3. Describe how Denali and other high mountains can impact weather and climate, and how the Alaska Range creates a rain shadow on its north side.
4. Conceptualize that some mountain ranges are formed due to tectonic plates colliding and subducting.
5. Describe how glaciers form and flow.

National Science Education Standards/Framework

- **ESS1.C: THE HISTORY OF PLANET EARTH (if the geologic timeline extension activity is completed)**
  How do people reconstruct and date events in Earth's planetary history?

- **Core Idea ESS2 Earth's Systems**
  How and why is Earth constantly changing?

- **ESS2.A: EARTH MATERIALS AND SYSTEMS**
  How do Earth's major systems interact?

- **ESS2.C: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES**
  How do the properties and movements of water shape Earth's surface and affect its systems?

Background Information

The Geology of Denali National Park and Preserve

The Alaska Range is a 600-mile long arc of mountains that stretches from the Alaska-Canada border all the way to the Alaska Peninsula. The range is highest at its midsection, a vast region of towering peaks and massive glaciers that lies within Denali National Park and Preserve. Denali is a region of great geologic activity and complexity, and scientists are only beginning to piece together its puzzling past. It has rock formations that have been carried here from thousands of miles away, fossils of ancient creatures that have been plowed up from ocean depths, new rocks born of the Earth's internal fire, and some of the oldest rocks in Alaska. The range's height and distance from the equator combine to make it a place of eternal winter, and deep snows compress to form glaciers (creeping rivers of ice which continuously grind away at the still-rising peaks). It would be considered one of the world's great geologic showcases even if it didn't contain the highest peak in North America.

Denali (Mount McKinley) is one of the most striking features on the entire planet. At 20,320 feet, it is the crowning peak of the Alaska Range and the highest mountain on the continent. It towers three and one-half vertical miles above its base, making it a mile taller from base to summit than Mt. Everest. (Denali starts at about 2,000 feet and rises over three and one-half miles to its 20,320 foot summit. Everest begins on a 14,000-foot high plain, then summits at 29,028 feet.) Permanent snow and ice cover over 75 percent of the mountain, and enormous glaciers, up to 45 miles long and 3,700 feet thick, spider out from its base in every direction. It is home to some of the world's coldest and most violent weather, where winds of over 150 miles per hour and temperatures of -93˚F have been recorded.

Land of Eternal Winter

Many consider Denali to be the world's coldest mountain because of its combination of high elevation and its subarctic location at 63 degrees north latitude. Mount Everest (29,028 feet) is the world's highest point above sea level, but it is at the same latitude (28 degrees north) as Florida's Walt Disney World. Denali sits 2,400 miles further north. This makes an enormous difference in temperature.

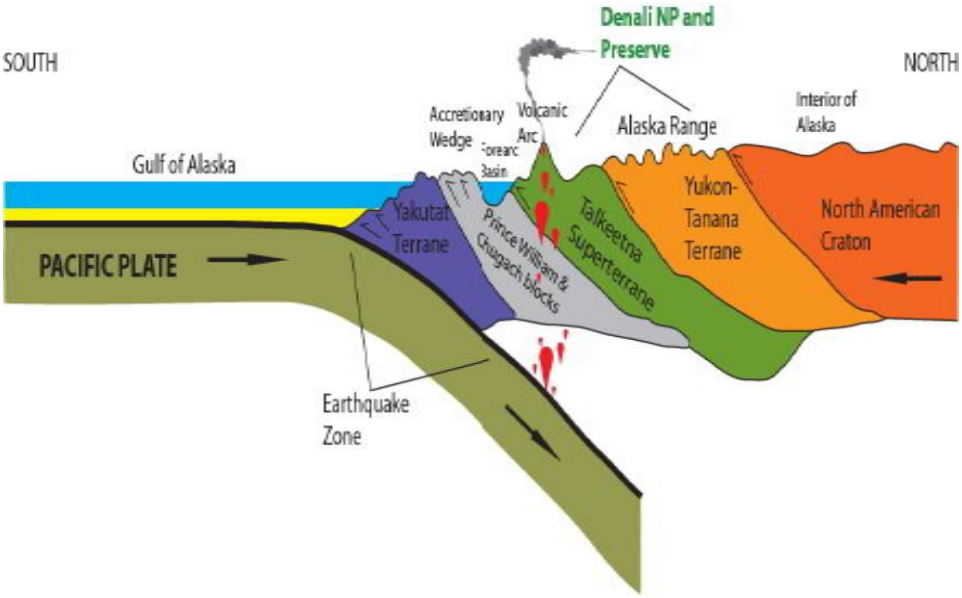
Denali is so massive that it generates its own weather; much the way a huge boulder submerged in a river creates whitewater rapids. All mountains deflect air masses and influence local conditions, but Denali rises so abruptly and so high that this effect is more dramatic here than perhaps anywhere else on Earth. Storms barrel in from the Gulf of Alaska and the Bering Sea and collide with Denali's towering mass. Weather can quickly change from sunny and clear to blizzard conditions with fierce winds, intense cold, and heavy snowfall. Climbers must pay close attention to warning signs of changing weather, and use their observations to plan when to climb, when to retreat, and when to dig in.

The Birth of a Mountain Range

The spectacular mountains we see today are a result of millions of years of rock formation, uplift, and erosion. The theory of **plate** tectonics provides the answer to how the Alaska Range was formed. To briefly tell this story, consider that Earth's crust is broken into great slabs of rock called **tectonic plates.** These plates float on the layer of Earth known as the mantle. The mantle is mostly solid, but it can move although very slowly.

One such tectonic plate, known as the Pacific Plate, forms the floor of the Pacific Ocean. It is slowly moving northward at about the rate that your fingernails grow. Oceanic plates are denser than continental plates. When an oceanic plate collides with a continental plate, the oceanic plate sinks below the continental plate in a process called **subduction.** The Pacific Plate is diving below the part of the North American Plate that holds Alaska's mainland.

The force of the Pacific Plate pushing northward creates tension between the two plates. The build-up and sudden release of tension as these plates slip by one another triggers earthquakes. Much the way the hood of a car buckles under the force of a collision, the process of subduction causes the uplift of the Alaska Range, as well as the coastal ranges. Scientists have determined that Denali rises at a rate of one half of a millimeter per year. That may not seem like much, but at that rate it will rise one kilometer in the next two million years--a brief period in geologic time.



From: **Denali National Park and Preserve** *Geologic Resources Inventory Report*
Natural Resource Report NPS/NRPC/GRD/NRR—2010/244, p. 3.

A Land Sculpted by Ice

Even as the uplift of the Alaska Range continues, weathering and erosion are constantly working to tear it down. Weather and water, in the form of wind, rain, frost, streams, rivers and glaciers, have the power to turn mountains into molehills.

In the high, frozen regions of the Alaska Range, snow and ice are the main forms of precipitation. In the past, most of the snow and ice remained behind; very little melting occurred. Snow and ice accumulated and got deeper and deeper, year after year, until the mass of ice that formed was so thick it compressed under its own weight. Gravity caused this ice to flow through stream valleys as glaciers. Glaciers are rivers of ice. The glaciers we see today in the park are increasingly small remnants of their former selves, but all around us we can see evidence of how they dominated the landscape. During past ice ages, most recently about 10,000 years ago, glaciers covered the Alaska Range and much of Alaska in ice. All of south-central Alaska has been buried in ice numerous times, and the shape of the land in this area comes from the carving forces of glaciers and the debris they leave behind.

Before Distance Learning Program

Time: 50-60 minutes (depending on what parts are assigned as homework)

Materials

For each student

- Copy of the Denali Geology – Student Reading
- Copy of the Denali Geology – Pre-activity: Graphing Mountain Elevation
- Sheet of graph paper
- Pencils and/or colored pencils
- A ruler or straight edge

For the class

- *Climbing Mount McKinley* (DVD) or online video (4 minutes)
- Computer setup for viewing DVD/online clip and for Skype conference session
- Clean glass jar
- Bag of marshmallows
- Cardboard disc, cut slightly smaller than the top of the jar
- Several, small, heavy weights (for example, rocks)

Getting Ready

1. **Check computer setup**. This is a good time to make sure your computer setup is functioning optimally for showing the online clip from the *Climbing Mount McKinley* video or using the DVD to show the video. You also want to make sure that the Skype application is functional. Check with a Denali Education Specialist if you have any questions or want to perform a pre-conference connection.
2. **Student reading.** Students are asked to read a short background about the geology of Denali National Park and Preserve. Decide whether you want them to read this as homework, in class individually, or together as a class.
3. **Submit class questions.** Have students collectively identify three questions they want to ask the education staff at the end of the Skype session. Please submit these questions to the Education Team at DENA_education@NPS.gov at least 24 hours in advance of the Skype session.

Procedure

1. **Introduce Denali**. Tell students that they are going to have the opportunity to meet the education staff in an online Skype session. Tell students that Denali National Park and Preserve is located in Alaska and gets its name from the mountain called Denali. Denali is the tallest mountain in North America at a height of 20,320 feet.
2. **On-line video/DVD.** Tell students that, for mountain-climbers, Denali is one of the goals on the list of Seven Summits. The Seven Summits are some of the highest mountains on Earth, each one being the highest mountain peak on its respective continent. Explain that you have a short video that describes what the climbing conditions are like on Denali. Before starting the video, ask students to identify three new and interesting things they learned about Denali while watching the video. Show the video.

3. **Discuss the on-line video/DVD.** Ask students to take a few moments in groups of three or four to discuss the three things they learned about Denali from the video. Then have a group leader report what their group came up with. You might want to keep a list of their notes on some chart paper.
4. **Pre-activity: Graphing Mountain Elevation.** Ask, *I wonder how Denali's elevation compares to other mountains in the United States?* Introduce the term **elevation** as the vertical distance of a mountain or other landform above sea level. Distribute copies of the Denali Geology - Pre-Activity: Graphing Mountain Elevation. Have students use the data on the chart to create a bar graph. Ask students to identify the tallest mountain (Denali) and the shortest land feature (Britton Hill, FL). Depending on your students' graphic abilities, you may need to provide additional guidance on how to create the graph. This activity could be assigned as homework along with the student reading that is included.
5. **Review Denali Geology – Student Reading.** If you have assigned the reading as homework, spend a few minutes reviewing what students have learned. Or, you can read the assignment in class, individually or as a class, concluding with a discussion of the information in the reading.
6. **Classroom demonstration: Glacial Pressure.** Conduct a classroom demonstration. Place marshmallows inside a cleaned-out jar to form a stack. Place a cardboard disc on top of the marshmallows. Place a weight on top of the disc and observe what happens. Ask students to observe what happens. Add additional weights and observe what happens. Can the students predict what will happen to the marshmallows between now and the Skype session?
7. **Identify three questions to ask the instructors.** Tell the students that the education staff has asked their class to come up with three questions that the class finds particularly interesting. You may want to brainstorm these questions in small groups, individually, or as a class. Tell students that they will have a chance to ask the education staff these questions at the end of the Skype session. Explain that the students can submit further questions about Denali to the Education Team at DENA_education@nps.gov.

Vocabulary

- **Elevation**: vertical distance above sea level
- **Erosion**: the process of carrying away weathered rock material
- **Glacier**: a slow-moving river of ice
- **Granite:** a type of rock with large mineral grains formed from magma that cools and solidifies deep within the earth
- **Rain shadow**: a region that has little rainfall because it is sheltered from rain-bearing winds by mountains or hills
- **Sea level**: the height of the ocean where it meets the land.
- **Subduction**: the sideways and downward movement of the edge of a tectonic plate as it dives beneath another plate
- **Tectonic plate**: one of the big slabs of rock into which Earth's crust is broken

During the Distance Learning Program

Time: 50-60 minutes

Materials

For the class

- Box or container of cornstarch
- Water
- Container for mixing oobleck
- Measuring cups for dry and liquid materials
- Pie tin or other pan for demonstrating oobleck
- Chairs on which the students can stand

Getting Ready

A Note about Oobleck
You might remember oobleck from the Dr. Seuss book, *Bartholomew and the Oobleck. It* was the name given to a type of goo that was capable of gumming up a whole kingdom. For our purposes, oobleck is a useful mixture of cornstarch and water that helps us model some of the properties of glacial ice. Oobleck can be both solid and liquid, depending on where you place it. It can be solid if you squeeze it in your hand or a liquid if allowed to flow freely. We are using oobleck to demonstrate what happens to snow and ice accumulated in a glacier.

1. **Mix the oobleck.** You will want to prepare one batch of oobleck before starting the videoconference. If possible, make the oobleck just before you start the presentation. If that's not possible, store it in a covered container in a refrigerator. When left at room temperature for a long period, oobleck can start getting moldy.
   Note: Don't show the oobleck to students before the videoconference.
   Here's the recipe.
   a. Mix one cup of water and one and a half cups of cornstarch, then work in more cornstarch if you want a more 'solid' oobleck.
   b. It will take about 5 minutes of mixing to get nice homogeneous oobleck.
2. **Consider the safety of having your students climb onto their chairs.** All of the students will be asked to briefly step onto their chairs during the Skype session. Let the education staff know in advance if you don't believe this is appropriate for your class. Students with mobility restrictions can participate by sitting/standing on anything higher than floor level.
3. **Establish Skype connection.** Make sure your Skype connection is up and running before beginning the session with Denali.

Procedure

1. **Orient your students.** Before signing on to Skype with the Denali education team, show students the set-up and go over any standards of behavior students should follow during the session. Remind them that the education staff may not be able to see everyone in the classroom, so they should look to you as an intermediary, if necessary, when they want to make a comment or ask a question.

2. **Connect with Denali.** At the designated time, use Skype to connect with the education staff. The program may last 50-60 minutes, depending on student input and questions.
3. **Let the communication begin!** Please be available to the education staff during the entire length of the program.
4. **After the program.** Take some time at the end of the program for students to discuss and provide feedback about their experience. Tell them that if they have further questions for the Denali education staff, they can contact them at DENA_education@nps.gov.

After the Distance Learning Program

Post-activity

Time: 30 – 45 minutes

Materials

For each student

- Copy of the Denali Geology – Post-activity: Denali's Geo logical T imeline
- Adding machine tape
- Pencils and/or colored pencils

Denali Geologic Timeline: Ask students to follow the instructions on the Post-activity sheet for creating a timeline of Denali's geologic history. You will need adding-machine tape for this activity. Using a scale where one millimeter equals a million years, have students label their adding-machine tape with the name and date of each event.

Extensions

- **Climbing Mt. McKinley.** Get a copy of the *Climbing Mt. McKinley* video from the Alaska Geographic Society and show the rest of the 17-minute video to your class. Discuss the video afterwards, having students consider the difficulties that face the mountain climbers and reasons for climbing the mountain. Ask them to write a paragraph or two about whether or not they would want to take on the challenge of climbing Denali.
- **Learn more about the "Seven Summits."** Have students find out what and where the other mountain peaks are in the Seven Summits. They might choose one for which to prepare a report or create a poster.
- **Do more Denali research.** Provide the further reading list for your students and encourage them to find a topic of interest to prepare a report, poster, PowerPoint, or some other type of presentation to share with the rest of the class.

Acknowledgments

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