

Geology of the National Parks, Quantitative Literacy, and the Natural Resource Challenge

Geologic exercise development using real data


Geology of the National Parks (GNP) is an on-line introductory-level geology course for non-science majors designed to teach geology in a succession of exercises by capitalizing on student interest in parks where geologic features and histories are so well displayed. In the past, most exercises involved virtual field trips and included writing assignments addressing specific questions about the trip. Currently, GNP is being overhauled to bolster the quantitative literacy dimension and gear more towards environmental geology by aligning with the National Park Service Natural Resource Challenge through a series of quantitative exercises using data collected at the parks. The exercises are presented in a Spreadsheets Across the Curriculum module in which students work with unit conversions, percent increase, ratios, probability, recurrence intervals and other foundation mathematics using the given data. To date, 21 modules have been developed incorporating data collected by researchers and made available through eight National Park Service Research Learning Centers.

Ten title pages from the collection:

SSACgnp.GB661.MCR1.1

Flood Days and Good Canoeing Days at Congaree National Park

Pick a random day. What is the probability that the water level of Cedar Creek will be within a particular range then? Use USGS stream data to find out.



Core Quantitative Literacy Topics
Probability

Supporting Quantitative Literacy Topics
Working with real data
Ratios, Percents
Variability

Core Geoscience Subject
Floods and flow frequency

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SSACgnp.QE521.JAM1.4

Yellowstone! A National Park on a Hot Spot



Core Quantitative Literacy Topics
Probability (Recurrence interval)

Supporting Quantitative Literacy Topics
Unit conversion
Percent


Core Geoscience Subject
Volcanism

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SSACgnp.HD9539.JAM1.3

Mined-Over Matter

Remembering Copper Mining at Keweenaw National Historic Park, Upper Peninsula Michigan



Core Quantitative Literacy Topics
Ratios

Supporting Quantitative Literacy Topics
Proportion
Percent
Unit conversion


Core Geoscience Subject
Mining and Mining Impacts

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SSACgnp.TN950.TMR1.1

Dunes, Boxcars, and Ball Jars: Mining the Great Lakes Shores

Something is missing at Indiana Dunes National Lakeshore. Take a trip back in time to see what once was and estimate what was lost.



Core Quantitative Literacy Topics
Estimation

Supporting Quantitative Literacy Topics
Volume
Conversions
Scientific notation
Geometry

Core Geoscience Subject
Coastal Dunes
Mining

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Example module:

SSACgnp.GD2403.JAM1.6

Glacier (?) National Park

Disappearing Glaciers in a Warming Climate



Core Quantitative Literacy Topics
Interpolation and Extrapolation

Supporting Quantitative Literacy Topics
Proportion
Percent
Unit conversion

Core Geoscience Subject
Global change: glacial recession

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Getting started

After completing this module you should be able to:

- Define glacier and climate.
- List evidence for global warming and how it is related to the glaciers in the park's glaciers.
- Know how to interpret and extrapolate data from a graph.

And you should also know where Glacier National Park is.

The setting - Glacier National Park

Glacier National Park is part of the Watkins Glacier International Peace Park, which was recognized as one of the world's great treasures by being designated a World Heritage Site in 1996. Here, Pleistocene (Pleistocene) sedimentary rocks have been thrust upward and eastward and are now covered by glacial till. Sedimentary rocks produced here are now seen in the park's glaciers.

Geology - Lewis Thrust Fault

The mountains of Glacier National Park began forming 170 million years ago when compressional forces of colliding tectonic plates shoved a huge, relatively strong rock wedge up and over weaker rock. With up to 50 kilometers of displacement, the stronger Precambrian rocks, several miles thick and several hundred feet over that of rock layers of the Lewis Thrust. That's about 1600 million years difference in age! Known as the Lewis Thrust, this dramatic fault is a major tectonic force that has shaped our Earth through time. Considerable erosion has occurred on the eastern edge of the thrust Precambrian rocks, but Chief Mountran, an isolated volcanic remnant remains.

Geology - rock exposures

Globally, Precambrian-age rocks have been extensively altered due to mountain building processes. In Glacier National Park, many details of environmental processes, such as mud cracks, ripple marks, and mudflow impressions, that occurred on Earth over a billion years ago, are visible in the park's Precambrian rocks. The weathering of these rocks has exposed the layers of the Lewis Thrust. The weathering of these rocks has exposed the layers of the Lewis Thrust. The weathering of these rocks has exposed the layers of the Lewis Thrust.

Animation of glacier recession

Watch the animation step through time from 1850 to 2100 and note the disappearance of glaciers and the associated environmental changes that occur.

Glacier recession

Global climate has changed rapidly with an average increase of 1.5° over the past 100 years. While this number may seem insignificant, noticeable changes have occurred in the glaciers in the park. In 1850, glaciers numbered around 150. By 1986, the number dropped to 50. As of 2009, 26 glaciers remained.

Grinnell Glacier

Question 1: Of the 160 glaciers in the park in 1850, what percentage remains in 2009?

Question 2: What is the percent decrease in the number of glaciers from 1850 to 1986 and from 1850 to 2009?

Question 3: Using the data provided (m), what is the area (mi², miles²) of Grinnell Glacier for each year given?

Question 4: What is the estimated area (mi²) of Grinnell Glacier in 1907 (interpolate)?

Question 5: Using extrapolation, in what year will Grinnell Glacier disappear (0 mi²)?

Retreating Grinnell Glacier

The United States Geological Survey (USGS) has [satellite data](#) for glaciers within the park as far back as 1950. The graph below shows the decrease in area through time for Grinnell Glacier and displays a second-order polynomial equation for the trend of the data.

Question 1: What is the area (mi²) of Grinnell Glacier in 1950?

Question 2: What is the area (mi²) of Grinnell Glacier in 2000?

Question 3: What is the area (mi²) of Grinnell Glacier in 2010?

Question 4: What is the area (mi²) of Grinnell Glacier in 2020?

Question 5: What is the area (mi²) of Grinnell Glacier in 2030?

Question 6: What is the area (mi²) of Grinnell Glacier in 2040?

Question 7: What is the area (mi²) of Grinnell Glacier in 2050?

Question 8: What is the area (mi²) of Grinnell Glacier in 2060?

Question 9: What is the area (mi²) of Grinnell Glacier in 2070?

Question 10: What is the area (mi²) of Grinnell Glacier in 2080?

Question 11: What is the area (mi²) of Grinnell Glacier in 2090?

Question 12: What is the area (mi²) of Grinnell Glacier in 2100?

Glacial retreat

Extrapolation of the data indicate that Grinnell Glacier will disappear by the year 2038. New findings indicate that if the warming trend continues, glaciers within the park may disappear by 2025. Rapid retreat of mountain glaciers is occurring globally as well. By 2100, earth's surface could be as much as 10° warmer than present, causing major changes to biota.

Warming impacts on the hydrologic cycle

The hydrologic cycle will be affected as well. More climate affects and intensifies the overall hydrologic cycle.

End-of-module assignment

After completing each of the spreadsheets in the module, use those same spreadsheets to answer the following questions changing information, values, and units where appropriate.

1. The estimated area of glaciers in South Carolina National Park was 218 mi² in 1900, 117.3 mi² in 1980, and 50.1 mi² in 1986. What is the percent decrease in the area of glaciers in the park from 1900 to 1986?
2. The temperature in the park for the year 1980 was 50.1°F. What is the percent decrease in the area of glaciers in the park from 1900 to 1986?
3. The temperature in the park for the year 1980 was 50.1°F. What is the percent decrease in the area of glaciers in the park from 1900 to 1986?
4. Using extrapolation, in what year will the Saryy Group disappear?

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Mapping Coastal Vulnerability to Sea-Level Rise at Point Reyes National Seashore



Core Quantitative Literacy Topics
Rank scales

Supporting Quantitative Literacy Topics
Average
Square root


Core Geoscience Subject
Global Warming: Sea-Level Rise

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SSACgnp.TD883.LV1.8

Take a Deep Breath on the Appalachian Trail in Great Smoky National Park

How Many Molecules of Ozone Do You Inhale?



Core Quantitative Literacy Topics
Ratio and proportion

Supporting Quantitative Literacy Topics
Scientific notation
Unit conversions
Graph reading
Orders of magnitude


Core Geo-Environmental Issue
Air Pollution

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Salmon Use of Geomorphically Restored Streams at Point Reyes National Seashore

Does stream restoration increase coho salmon use of streams? Use National Park Service salmon-use data to find out.



Core Quantitative Literacy Topics
Comparisons: absolute and relative differences

Supporting Quantitative Literacy Topics
Making graphs
Percent differences


Core Geoscience Subject
Fluvial geomorphology; Fish habitat

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Getting to the Point

Exploring the Tectonic Motion of Point Reyes National Seashore, California



Core Quantitative Literacy Topics
Numerical operations

Supporting Quantitative Literacy Topics
Proportion
Unit conversion
Logarithmic scale


Core Geoscience Subject
Earthquake geology

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SSACgnp.TC225.MHH1.1

Shifting Sands: Quantifying Shoreline and Dune Migration at Indiana Dunes National Lakeshore

Using time-series aerial photos to determine the average rate that the shoreline and dunes have moved inland.



Core Quantitative Literacy Topics
Weighted average

Supporting Quantitative Literacy Topics
Rate of change


Core Geoscience Subject
Coastal Erosion

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A Percentage Stroll through Norris Geyser Basin, Yellowstone National Park

The variety of hydrothermal features provides opportunity for a variety of percentage calculations



Core Quantitative Literacy Topics
Percentage

Supporting Quantitative Literacy Topics
Unit conversions, logarithms

Core Geoscience Subject
Hydrothermal features

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