

# Bonus - Yellowstone Activity



## WILL IT BLOW?

Monitoring Yellowstone's Volcanic Activity

### LESSON PLAN

By:  
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#### National Standards:

Physical Science Standard B

Motion and Forces

Transfer of Energy

Earth and Space Science Standard D

Energy in the Earth System

Geochemical Cycles

Origin and Evolution of the Earth System

Science and Technology E

Science in the Personal and Social Perspective F

Natural and Human-Induced Hazards

#### Objectives:

Following completion of these activities and demonstrations students will be able to:

Describe why and how volcanoes are monitored

Explain the role that GPS has played in advancement of science overall

Graph GPS data either by hand or using a spreadsheet

Interpret the meaning of graphed GPS data

Describe how volcanic processes alter the surface of the earth

Explain the source of the force and energy required for volcanic processes

Describe how matter and energy are conserved during volcanic processes

Discuss the hazards associated with volcanic processes

#### Time:

Why do scientists monitor volcanoes discussion

15 minutes

The Science of Prediction PowerPoint

30 minutes

Where AM I: the evolving technology of navigation

1 class period

Will it Blow

3-class periods

#### Outline:

##### **Why do scientists monitor volcanoes?**

(Discussion with examples of hazards)

Ask students how they benefit from the USGS' Volcanic Monitoring Program

For example:

Self, family or friends live on a volcano (Ash, Lahar, Pyroclastic Flow, Lava Flow)

Live near a volcano (Ash, Lahar)

Like to visit volcanoes (hiking, fishing, 4-wheeling, hunting, rock climbing)

Fly on airplanes (ash)

Live on Earth (ash, volcanic aerosols and greenhouse gases)

This is a good time to discuss the hazards that are associated with volcanic processes. Students are usually familiar with eruptions and lava flows, but not likely to relate to hydrothermal features, gas emissions, or volcanic mud flows

USGS Types and Effects of Volcano Hazards

<http://volcanoes.usgs.gov/hazards/>

USGS Fact Sheet What are Volcano Hazards

<http://pubs.usgs.gov/fs/fs002-97/fs002-97.pdf>

### **The Science of Prediction: Monitoring Volcanic Activity**

(PowerPoint)

[www.unavco.org/cws/modules/cws/modules/yellowstone/](http://www.unavco.org/cws/modules/cws/modules/yellowstone/)

Students learn about how scientists monitor volcanic activity and how such monitoring detected the impending eruption of Mt. St. Helens in 1980.

For more information about volcanic hazards and monitoring check out these resources:

Volcano and Hydrologic Monitoring Techniques

[http://vulcan.wr.usgs.gov/Monitoring/techniques.html#seismic\\_monitoring](http://vulcan.wr.usgs.gov/Monitoring/techniques.html#seismic_monitoring)

USGS Volcanic Gas Fact Sheet

<http://vulcan.wr.usgs.gov/Glossary/Emissions/Publications/OFR95-85/>

USGS Fact Sheet "Steam Explosions, Earthquakes, and Volcanic Eruptions—What's in Yellowstone's Future?" <http://pubs.usgs.gov/fs/2005/3024/fs2005-3024.pdf>

Mt Rainier NP "Living with a Volcano in your Backyard" curriculum

<http://vulcan.wr.usgs.gov/Outreach/Publications/GIP19/framework.html>

Tree kills

<http://pubs.usgs.gov/fs/fs172-96/>

### **Where AM I: the Evolving Technology of Navigation**

(worksheet)

[www.unavco.org/cws/modules/cws/modules/yellowstone/](http://www.unavco.org/cws/modules/cws/modules/yellowstone/)

Students will use several web pages to research the history of navigation leading to the development of GPS. They will then design a timeline to illustrate and communicate their findings.

#### **Adaptations:**

Students with disabilities Print out "The History of Navigation"

<http://www.boatsafe.com/kids/navigation.htm>” from the WebQuest document. Have students cut out important technological advances and paste on a timeline. Students could also illustrate their timelines.

No Access to Computers Print out each of the WebQuest web pages. Have students work in groups to construct a timeline from the available information

Advanced Students Have students decide which type of technology on their timeline they consider the most important step leading to the design of GPS and present their reasoning to the class. Have students predict a future application of GPS and write about it.

### **What is GPS?**

(PowerPoint, worksheet)

<http://www.unavco.org/cws/modules/cws/modules/readingGPStimeseries/>

If students are unfamiliar with GPS and how it works, you might want to do this activity as a starter

### **Will It Blow: Monitoring Yellowstone’s Volcanic Activity?**

(PowerPoint, worksheet, Yellowstone GPS Data Set)

[www.unavco.org/cws/modules/cws/modules/yellowstone/](http://www.unavco.org/cws/modules/cws/modules/yellowstone/)

Students interpret historical and real-time monitoring data for Yellowstone NP to determine if there is a space suitable for building a golf resort in the park. Students are asked to construct a presentation or written report to submit to the developer based on the National Science Standards format

*The Yellowstone GPS data set uses only vertical data, however if you plan on using other EarthScope activities, this PowerPoint is good background material.*

How to read GPS time series plots

[\(PowerPoint\)](#)

### **Adaptations:**

Students with disabilities Print out diagrams from PowerPoint “The Science of Prediction” or use the USGS Fact Sheet “Steam Explosions, Earthquakes, and Volcanic Eruptions—What’s in Yellowstone’s Future?”

<http://pubs.usgs.gov/fs/2005/3024/fs2005-3024.pdf>. Have students place X’s on a map to represent unsuitable development sites. They can then verbally discuss where development could take place or shade suitable sites on the map

No Access to Computers Print out each of the materials. Have students work in groups to collect and interpret data. Classroom copies of USGS “Steam Explosions, Earthquakes, and Volcanic Eruptions—What’s in Yellowstone’s Future?” can be printed from the internet or requested from the USGS publications office.

Advanced Students Students can go deeper into the analysis of GPS data by analyzing time series for each station and plotting vectors on their maps Instructions for plotting GPS vectors can be found at

[http://cws.unavco.org:8080/cws/modules/gps\\_pacificnw\\_cascadia/](http://cws.unavco.org:8080/cws/modules/gps_pacificnw_cascadia/). Have students research additional hazards such as forest fires and flooding to add to their reports. Students could present their findings to the “developer” and then debate any differences.

**Extension Ideas:**

Students can research hazards at St. Augustine volcano

<http://www.avo.alaska.edu/activity/Augustine.php>

Students can prepare a volcanic hazards map for Yellowstone based on their research

Students can discuss possible mitigation techniques for Yellowstone’s hazards such as signage, emergency drills, emergency supplies etc.

Compare the volcanic hazards at Yellowstone to those of other types of volcanoes such as Kilauea, Mt. St. Helens, Mt Rainier, Mt. St. Augustine, Mt. Fuji etc.



## WILL IT BLOW?

Monitoring Yellowstone's Volcanic Activity

STUDENT WORKSHEET

By:  
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### Objective:

**Interpret historical and real-time monitoring data for Yellowstone National Park**  
**Analyze monitoring data to detect regions of high and low risk of volcanic hazards**  
**Construct a report communicating your findings**

### Problem:

- Congratulations! You're a private consultant and you have just been awarded a \$100,000 contract from a major developer.
- This developer would like to build a 3500 acre (5.5 mi<sup>2</sup> or 8 km<sup>2</sup>) resort and golf course in Yellowstone National Park.
- Your task is to prepare a report advising the developer as to the most risk-free place (if there is one) in the park to build his resort.

### Introduction:

Review PowerPoint "The Science of Prediction: Monitoring Volcanic Activity"  
([www.unavco.org/cws/modules/cws/modules/yellowstone/](http://www.unavco.org/cws/modules/cws/modules/yellowstone/)) before beginning this activity.

### Materials:

Map of Yellowstone NP  
Colored Pencils  
Graph paper or Excel/spreadsheet program  
Monitoring Yellowstone's Volcanic Activity PowerPoint (computer, print copies or projection screen)  
Yellowstone GPS data set (Excel file or print copies)  
Real-time data (Access to Internet or print copies)

### Procedure:

1. Open the PowerPoint "Instructions for Monitoring Yellowstone's Volcanic Activity"  
([www.unavco.org/cws/modules/cws/modules/yellowstone/](http://www.unavco.org/cws/modules/cws/modules/yellowstone/) )  
This PowerPoint describes the current and historical monitoring data at Yellowstone NP  
Some slides will ask you to follow a link to real-time data using the internet or your teacher may provide print copies for you to analyze  
  
You will also be graphing data from the "Yellowstone GPS data set"  
([www.unavco.org/cws/modules/cws/modules/yellowstone/](http://www.unavco.org/cws/modules/cws/modules/yellowstone/) )
2. As you follow along with the presentation, use the "Yellowstone National Park map" on the last page to record your data. Here are a few suggestions to complete this task:
  - \*\*Construct a key for your map
  - \*\*You may want to do a field "notes" copy of your map and a final copy
  - \*\*Accuracy and detail are important but it needs to be readable too
  - \*\*Use colored pencils

## GPS Part I

When you get to the section on Ground Deformation follow these steps

- Find four (4) GPS stations (green dots on the map) located along the same transect "line" as the Leveling Data (Lake Butte to Mount Washburn)
- Look up each of these stations on the "Yellowstone GPS data set" using it's 4-letter station ID
- Construct a line graph using the **station ID as the X-axis** (in the same order as would be recorded on the Leveling data) and the **change in height on the Y-axis**. *The X-axis will NOT be to scale like the Leveling Data is. If you would like to use the same scale, you can use a map of the park and measure the distance each station is from Lake Butte*
- Use a different color for each year's data or construct a separate graph for each year
- Answer the questions in the analysis portion of the activity

## 3. GPS Part II

- Using the "Yellowstone GPS data set" construct a scatter plot FOR ALL OF THE GPS STATIONS using the **station longitude as the X-axis** and the **change in height on the Y-axis**
- Use a different color for each year's data or construct a separate graph for each year
- Repeat steps a and b only this time use the **station's latitude as the X-axis** instead of longitude. *If you are using Excel to graph your data, another useful graph is the "circle plot". Use Longitude for the X-axis and Latitude for the Y-axis. The Z-value (size of the circle) is the change in height. This graph can give you a good picture of where deformation is taking place on the surface.*

**Data:** Your data will be your labeled map and your graphs

**Analysis:** Answer each of the following questions regarding the data you collected

**Volcanic Eruption data:**

How often does the Yellowstone Hot-spot create a new caldera?

What types of volcanic eruptions are associated with Yellowstone?

How are these volcanic eruptions dangerous?

In your professional opinion, is there an immediate (next 100 years or so) danger related to volcanic eruptions at Yellowstone?

**Volcanic Gasses data:**

What gasses are monitored at Yellowstone?

How are these gasses dangerous?

In your professional opinion, is there an immediate (next 100 years or so) danger related to release of volcanic gasses at Yellowstone?

**Hydrothermal Activity data:**

How is hydrothermal activity dangerous?

In your professional opinion, is there an immediate (next 100 years or so) danger related to hydrothermal activity at Yellowstone?

### **Earthquake Activity data:**

How are earthquakes dangerous?

How many modern day large (greater than magnitude 5) earthquakes have occurred at Yellowstone?

What is the most common size of earthquakes recorded at Yellowstone?

Does the pattern of earthquakes at Yellowstone suggest movement of magma? (Remember the pattern at Mt. St Helens.

In your professional opinion, is there an immediate (next 100 years or so) danger related to earthquakes at Yellowstone?

### **Ground Deformation data:**

How is ground deformation dangerous?

What pattern do you observe in the historic data?

Is this pattern observed in the real-time GPS data?

Why might the Leveling data be different than the GPS data? (HINT: think about how and when each is measured)

In your professional opinion, is there an immediate (next 100 years or so) danger related to ground deformation at Yellowstone?

### **Conclusions:**

Here is your opportunity to demonstrate what you learned about the hazards and monitoring at Yellowstone NP.

Your conclusions should include all of the following components

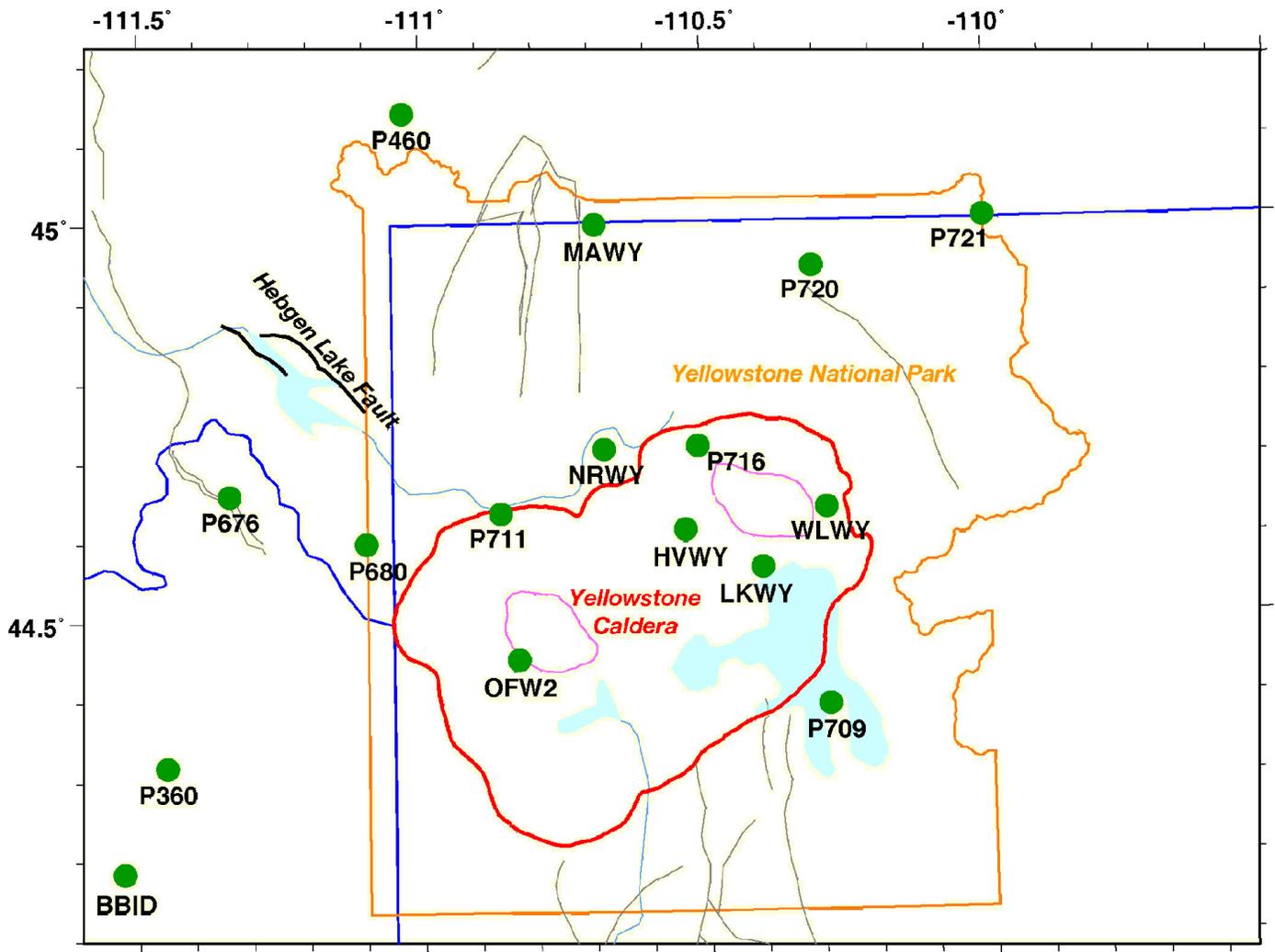
RESTATE THE PROBLEM—remind the developer of what he is paying you to do

SUMMARIZE THE DATA YOU COLLECTED—developers are not usually scientists, that's why they had to hire you. Explain to them what data you collected and what it means.

DESCRIBE YOUR RECOMMENDATIONS—be specific as to where you think it is appropriate for development to take place.

SUPPORT YOUR RECOMMENDATIONS—explain why the developers should accept your recommendations. Use specific details from your data. You should also describe any further data collection that needs to take place.

### Yellowstone National Park



↔  
5 km

Image from University of Utah College of Mines and Earth Sciences "Continuous GPS Station Information" [http://www.mines.utah.edu/~ggcmpsem/UUSATRG/GPS/time\\_series.html](http://www.mines.utah.edu/~ggcmpsem/UUSATRG/GPS/time_series.html)