Exploring Earth's Volcanic Environments
Vesuvius 79AD Eruption

FIELD NOTEBOOK

NAME(S) _____

CLASS _____

INSTRUCTOR(S) _____

DATE _____

Introduction

Explosive volcanism poses significant hazards to people and the Earth's environment. In this web exercise you will learn about the processes of explosive volcanism by exploring one of the world's most famous volcanic disasters; the 79AD eruption of Mount Vesuvius in Italy. The study of this eruption combines interesting aspects of both volcanology and archeology. You will take a virtual fieldtrip to Italy where you will climb the volcano, study the volcanic deposits, and make your own interpretations about how the volcano impacted the Roman cities of Pompeii and Herculaneum.

This project was conceived and developed by Professors Steven Carey and Haraldur Sigurdsson of the Graduate School of Oceanography, University of Rhode Island, Narragansett, R.I. Support for its development and implementation was provided by a grant from the Undergraduate Education Division of the National Science Foundation (DUE0341460).

How to Proceed

The tasks that you will find in this notebook and the website can be completed individually or as a team of up to 3 students. The average time to complete the exercises is about 2 hours. You may stop and return to the exercise at another time if needed. All of your work is recorded in your field notebook document. **Please note that the tasks should be completed sequentially.** Each task is designed to give you a base of understanding to complete the following tasks. It is to your benefit to finish each task before moving on.

There are 10 tasks to be completed during the exercise. This notebook contains specific questions and areas for each of the tasks as you move through the website. You will be asked to record observations, draw diagrams, formulate hypotheses, and plot graphs in your notebook when you see this field book icon (right) on the webpage.

Task

Look for this icon to complete a task!

Observing Explosive Volcanic Eruptions

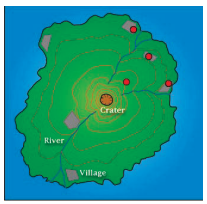
In this section you will watch videos of three examples of explosive volcanic eruptions and examine their effects on the surrounding countryside. As you make your observations recall some of the details that Pliny the Younger wrote down when he witnessed the 79 AD eruption. You will see that different styles of eruptions can have dramatically different impacts on the area around a volcano. The video clips that you will watch are from explosive eruptions of the Soufriere Hills volcano on the island of Montserrat in the West Indies in the late 1990s. Many of the eruptions of this volcano are similar to the events that took place at Vesuvius in 79 AD and thus serve as excellent examples to understand explosive volcanism in general.

Rendition of Pliny the Younger (blue robe) during the 79 AD eruption by Angelica Kauffmann (1875).

For each eruption do the following:

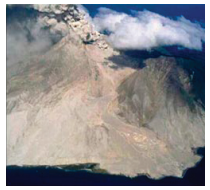
1. Watch the video clip.
2. Examine the effects of the eruption on the area surrounding the volcano.
3. Answer the questions on the next page.

Video clips



Eruption effects

Eruption 1



Eruption 2

Eruption 3

What are the main differences in the motion of material being discharged from the volcano during the three different eruptions?

What are the main differences in the effects of the different eruptions on the surrounding countryside?

Based on your observations which eruption do you think was the least dangerous and why?

Based on your observations which eruption do you think was the most dangerous and why?

Interpretation

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It's now time to interpret what you have seen in the three eruption videos. The purpose of this part of the exercise is to come up with preliminary interpretations based solely on your own observations of the volcanic processes and their effects. These should be simple and concise. Pliny the Younger included some of his own interpretations in his letters describing the 79 AD eruption of Vesuvius.


Eruption 1


Eruption 2


Eruption 3

Eruption 1

Eruption 2

Eruption 3

Volcanic Particle Transport in the Atmosphere

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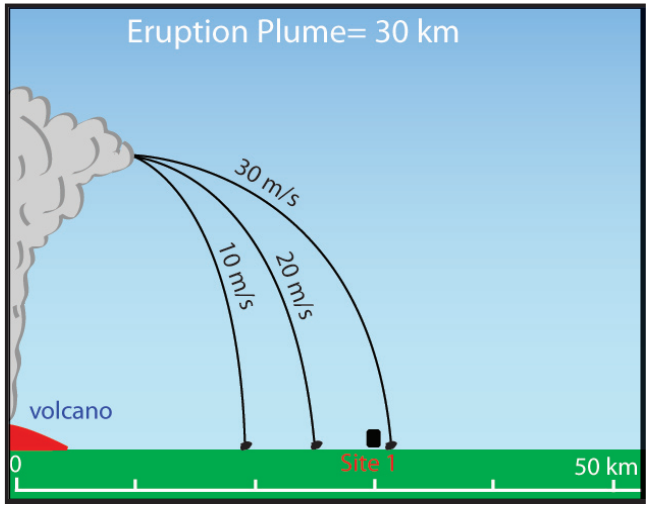


A 1 cm diameter particle from an explosive eruption of a volcano has been found at Site 1 located 30 kms downwind. Place the cursor over the plume heights to see what combination of plume height and wind speed would transport the particle this far. Specify both the plume height and wind speed.

In general, what happens to the dispersal of particles of similar size as the eruption grows in height?

How would you expect the size of volcanic particles to change at a fixed distance downwind from the volcano, if the eruption column grew in height during an eruption?

Behavior of Eruption Columns

Based on your observations of the eruption video clips you should now realize that the behavior of explosive volcanic eruption columns can be quite different. The potential impact of these eruptions on people living around the volcano is very much a function of how the erupting mixture of gas and particles behaves once it leaves the vent. In this part of the exercise you will learn more about what factors control the behavior.

Observe the effects of magma discharge rate and gas content on the eruption behavior by selecting different settings and clicking "Erupt"?

Record your observations in the table below. Indicate whether the eruption was rising (R) or collapsing (C) and estimate the maximum height of the column. The first one has been done for you as an example.

Gas Content →

Magma Discharge Rate (kg/s)	1%	2%	3%	4%	5%
10^5	R 9	R 9	R 9	R 9	R 9
10^6					
10^7					
10^8					
10^9					

Impact of Pyroclastic Flows and Surges

Pyroclastic flows and surges are the two most destructive phenomena of volcanic eruptions. They travel at high velocity and can be as hot as 600 degrees C. Much of their destructive potential lies in the energy of the flow moving at high speeds. Their effects are often dramatically illustrated by the remains of buildings and other objects that were in their path during an eruption.

Using the flow animation, evaluate the destructive potential of pyroclastic flows and surges on buildings and other objects. What are the minimum velocities necessary to destroy a building by air (wind), pyroclastic surge, and pyroclastic flow?

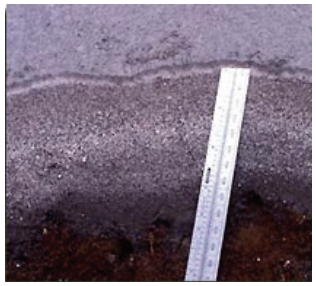
Flow Type	Minimum speed (mph) needed to destroy a building
Air	
Pyroclastic surge	
Pyroclastic flow	

What do you think are the principal reasons for the differences in destructive potential between the different types of flow (wind, pyroclastic surge, and pyroclastic flow)?

Deposits from Explosive Eruptions

Explosive eruptions produce and disperse fragmental material in a number of different ways. Each process produces a deposit with characteristic features such as thickness, grain size, sorting, and sedimentary features.

Eruption 1



Deposits

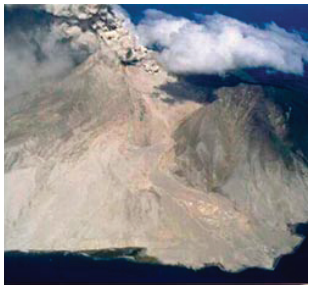
Examine the deposit of Eruption 1 and record its properties, such as grain size, thickness, sorting, color, and layering.

Distance from volcano: 3 kilometers

	Grain size	Thickness	Sorting	Color
Layer				

Distance from volcano: 15 kilometers

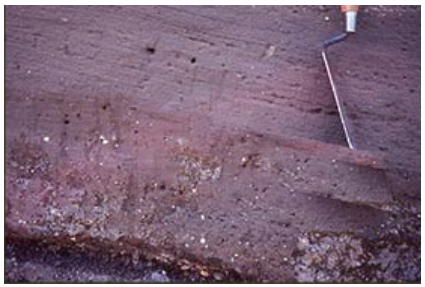
	Grain size	Thickness	Sorting	Color
Layer				



Eruption 2

Examine the deposit of Eruption 2 and record its properties, such as grain size, thickness, sorting, color, and layering.

Layer	Grain size	Thickness	Sorting	Color
base				
middle				
top				



Eruption 3

Examine the deposit of Eruption 3 and record its properties, such as grain size, thickness, sorting, color, and layering.

	Grain size	Thickness	Sorting	Color
Layer				

Vesuvius: A Dangerous Volcano

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The summit area of Mt. Vesuvius is quite complex owing to the long history of volcanic activity. The principal structures are the old Monte Somma rim, formed by collapse of a large ancestral volcano and the young cone with the active crater of Vesuvius. The young cone is 330 meters deep. Inside the cone the vertical walls show the internal structure of the volcano.

Click on the three red dots on the crater map to see panoramic views from the rim.

Describe any structures that you can see on the steep crater walls.

What might have caused the formation of these structures?

As you look around from the top of the volcano why do you think it's considered so dangerous?

Pompeii: Explore the City

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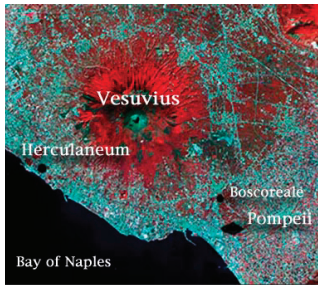

In 79 AD, Pompeii was a prosperous town of about 20,000 people, located about nine kms southeast of Vesuvius volcano. It was the site of both commercial and political activity. In 62 AD, the city was rocked by a strong earthquake that caused considerable damage. At the time of the 79 AD eruption many of the buildings were still under repair.

The eruption buried the city under about three meters of pumice and ash. It was rediscovered in 1748 when excavations in an area known as "Civita" uncovered artifacts and buildings. Subsequently, about three quarters of the city have been excavated from the volcanic deposits.

Using the QTVR image and the data collection interface, you will be able to collect information about the 79 AD volcanic deposits at the Necropolis section in Pompeii.

Necropolis Section

Describe the features of ***all of the layers*** in the deposit section such as grain size, thickness, sorting, color, or special objects. Note any variations of grain size or sorting that might occur within individual layers.

Eruption Type

In the last column of the table, compare the characteristics of each layer with deposits from eruptions 1, 2, and 3 and decide which eruption type produced each layer. For example, one layer's characteristics might be most similar to deposits from eruption 3 whereas another might be most like deposits from eruption 2. *Although it is important to compare many of the features, the most important parameter to focus on is sorting.* Just write in 1, 2, or 3 in the column once you've made your interpretation.

Layer	Thickness	Color	Grain size	Sorting	Spec. Objects	Eruption Type
1						
2						
3						
4						

Herculaneum

In 79 AD, Herculaneum was a small city situated on the coast overlooking the Bay of Naples, six kms west of the volcano. The population has been estimated to be about 5000 people. Unlike Pompeii, which was a busy commercial center, Herculaneum was a quieter seaside resort.

The eruption buried the city under about 20 meters of thick pumice and ash. It was rediscovered in the 1700s when tunneling uncovered artifacts and buildings. Excavation of the city has been impeded because of the presence of the modern city of Ercolano, built directly on top of the ruins. The excavations of Herculaneum uncovered few human remains until the 1980s when hundreds of skeletons were found in boat chambers along the beachfront. People had apparently gathered in this area in an attempt to escape the terrifying effects of the eruption.

Palaestra Section

Describe the features of ***all of the layers*** in the deposit section such as grain size, thickness, sorting, color, or special objects. Note any variations of grain size or sorting that might occur within individual layers.

Layer	Thickness	Color	Grain size	Sorting	Spec. Objects	Eruption Type
1						
2						
3						

Villa of the Papyri Section

Describe the features of ***all of the layers*** in the deposit section such as grain size, thickness, sorting, color, or special objects. Note any variations of grain size or sorting that might occur within individual layers.

Layer	Thickness	Color	Grain size	Sorting	Spec. Objects	Eruption Type
1						
2						
3						

Construct a Hypothesis

It's now time construct a hypothesis of what you think happened at Pompeii, and Herculaneum during the 79 AD eruption of Vesuvius. This hypothesis will utilize what you have learned about explosive eruptions and the observations that you have made of the volcanic deposits in Pompei and Herculaneum.

Follow these steps to construct a working hypothesis.

1. Review your field observations and determine the type of volcanic process that formed the various layers in each locality (e.g. pumice fallout, pyroclastic flows, or pyroclastic surges). Use what you learned about the link between deposit characteristics and eruption type from the early part of the exercise.

2. Compare your interpretations of processes at Pompeii and Herculaneum and see how they might differ. How could an eruption produce different effects at different locations around the volcano?

3. Construct a complete scenario of the burial of the cities during the 79 AD eruption, using the information from the volcanic deposits, the position of the cities relative to the volcano, and the timing of the beginning of volcanic deposition in each area.

IMPORTANT CLUE

Timing of the eruption: The eruption of Vesuvius began in the early afternoon of August 24, 79 AD. Formation of volcanic deposits at Pompeii began shortly thereafter, probably around 1 pm. In contrast, at Herculaneum the first deposits from the eruption were not laid down until about 1 am on the morning of August 25.

What was the sequence of events that caused the burial of Pompeii (e.g. pyroclastic flows, pumice fall, pyroclastic surge, etc.)? Cite specific evidence from your interpretation of the deposits.

VESUVIUS VOLCANO
79 AD Eruption
Virtual Fieldtrip

What was the sequence of events that caused the burial of Herculaneum (e.g. pyroclastic flows, pumice fall, pyroclastic surge, etc.)? Cite specific evidence from your interpretation of the deposits.

Why do you think the cities were affected in very different ways during the eruption? Consider their position relative to the volcano.