ScienceNews
EDUCATOR GUIDE

NASA EARTH OBSERVATORY

August 28, 2021
Sea Level Dips Spur Volcanic Eruptions

SOCIETY FOR SCIENCE

SN EDUCATOR GUIDE

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About this Guide

In this Guide, based on the online *Science News* article "Greece's Santorini volcano erupts more often when sea level drops," students will learn about how scientists used a computer simulation to show that sea level might influence volcanic eruptions. Then, students will discuss computer simulations and brainstorm a simulation that they could use to investigate a real-world issue.

This Guide includes:

Article-based Comprehension Q&A — Students will answer questions about the online *Science News* "Greece's Santorini volcano erupts more often when sea level drops," which describes how a computer simulation revealed a hidden relationship between sea level and a volcano's explosive history. A version of the story, "Sea level dips spur volcanic eruptions," appears in the August 28, 2021 issue of *Science News*. Related standards include NGSS-DCI: HS-ESS1; HS-ETS1.

> **Student Comprehension Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

Cross-curricular Discussion Q&A — Students will discuss the purpose, benefits and challenges of using computer simulations in scientific research. Then, students will brainstorm a real-world issue that could be investigated with a computer simulation and think about how the simulation would work. Related standards include NGSS-DCI: HS-ESS1; HS-ETS1.

> **Student Discussion Worksheet** — These questions are formatted so it's easy to print them out as a worksheet.

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Article-based Comprehension, Q&A

Directions for teachers: Ask students to read the online *Science News* "Greece's Santorini volcano erupts more often when sea level drops," which describes how a computer simulation revealed a hidden relationship between sea level and a volcano's explosive history. A version of the article, "Sea level dips spur volcanic eruptions," appears in the August 28, 2021 issue of *Science News*.

1. What is Santorini and where is it located?

Santorini is a ring of Greek islands surrounding the tip of a volcano jutting out of the Aegean Sea.

2. What was the Santorini volcano like before 1600 B.C.? What happened to the volcano that year?

The volcano was above water before 1600 B.C. That year, a violent eruption caused part of the volcano to collapse, creating a lagoon.

3. A claim is an assertion of something as a fact, which may or may not be supported by evidence. What is one scientific claim made by the scientist as described by the article?

Changes in sea level after the Santorini volcano partially collapsed influenced its eruptions.

4. Claims often serve as answers to questions. What scientific question might the scientist's claim attempt to answer?

What specific stresses can impact volcanoes located in or around large bodies of water?

5. Evidence is the scientific data that are given to support a claim. What information does the article give as evidence? Be sure to state where the evidence comes from.

A computer simulation of the volcano's magma chamber showed that when the sea level dropped 40 meters or more below the present-day level, the crust above the chamber cracked, allowing magma to make its way to the surface. After water rises again, the cracks eventually close and eruptions stop, according to the simulation. Comparing geologic data of past sea level with the volcano's eruption history supported the simulation's prediction.

6. Reasoning is the explanation of why the evidence supports the claim. What reasoning is given in the article?

One statement of reasoning that loosely relates the evidence back to the scientist's claim is that other studies have found a similar relationship between volcanoes in Iceland and glaciers. Icelandic volcanoes have shown an increase in eruptions after glaciers that were once on top of them melted, relieving the system of the ice's weight.

7. What do the findings mean for the Santorini volcano today, according to scientists?

The Santorini volcano will likely remain relatively quiet, scientists say, because the last time sea level was 40 meters below the present-day level was thousands of years ago near the end of the last ice age and sea level is rising due to climate change. But violent eruptions are still possible — two historic major eruptions happened when sea levels were high.

8. How might the findings apply to other volcanoes?

Sea levels probably influence other volcanoes. More than half of the world's volcanic systems are in or near oceans.

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Cross-curricular Discussion, Q&A

Directions for teachers:
The first set of questions can be discussed as a class, or you could ask students to answer the questions with a partner. Then have students read the online *Science News* article "Greece's Santorini volcano erupts more often when sea level drops" and answer the last two sets of questions on their own. A version of the article, "Sea level dips spur volcanic eruptions," appears in the August 28, 2021 issue of *Science News*.

Want to make it a virtual lesson? Post the online *Science News* article to your virtual classroom. Discuss the article and questions with your class on your virtual platform.

Defining simulations

1. What is a computer simulation and what is it used for in science? Name one example of a system that scientists study with computer simulations.

Computer simulations are representations of real-life systems or situations; simulations use mathematical equations and real-world data to imitate the conditions and functions of those systems. Scientists use simulations to test how a system would respond to certain stresses. Scientists simulate Earth's climate system to study climate change.

2. What are the benefits of using a computer simulation? When might it be necessary?

Computer simulations allow scientists to evaluate processes that they otherwise wouldn't be able to. Some real-world systems are too large or too small to investigate by other means. A process in a real-world system that scientists want to investigate might occur over very long or very short timescales. Or perhaps a real-world system might be inaccessible or too dangerous for a scientist to investigate in person. Simulations also allow scientists to forecast outcomes for hypothetical situations and situations that could occur in the future.

3. What might be some challenges or limitations of using a computer simulation?

A simulation is only as good as the data, equations and rules used to create it. Mistakes made in the programming or rules can throw off the simulation's accuracy. And it can be very difficult to create an entirely realistic simulation in the first place — simulations exist in a vacuum and may not account for all variables in a real-world system. What's more, a lack of good data can lead to necessary assumptions that may also affect a simulation's accuracy.

4. What is a visualization? How do visualizations differ from simulations?

A visualization depicts a set of data to aid interpretation of that data set. Visualizations differ from computer simulations in that visualizations aren't used to predict outcomes to alternative conditions.

The Santorini simulation

1. What complex problem did the scientists investigate with a computer simulation? List some basic components of the system that scientists simulated.

The researchers investigated how sea level affects Santorini's volcanic activity. The simulation modeled the Santorini volcano's magma chamber and included Earth's crust and the Aegean Sea in the system.

2. Why do you think the scientists used a computer simulation? What scientific relationships or principles might scientists have used to create the simulation?

Scientists likely used a computer simulation because it helped them test the impact of past sea level changes on volcanic activity over hundreds of thousands of years. Testing sea level change on volcanic activity is something scientists are unable to do in person in real time. Scientists might be able to use equipment to gather data on sea level, Earth's crust and a volcano's magma chamber, but the relationship between these components plays out over very long time periods. The simulation likely incorporated data on the physical conditions of the magma chamber such as its depth, volume and pressure; properties of the magma such as temperature and volume; properties of Aegean Sea water including its level; and properties of Earth's crust including its geologic makeup and how much pressure it is under. The simulation's mathematical algorithms define relationships among the variables in the system, such as the relationship between sea level and the pressure on Earth's crust.

3. What variables did scientists alter to get relevant predictions, or output, from the simulation? How did scientists test the accuracy of the simulation?

Scientists varied sea level and thus the pressure the water exerts on Earth's crust. Scientists tested the accuracy of their simulation by comparing the output data with the historical sea level and volcanic eruption data.

Create your own simulation

1. Brainstorm a complex, real-world issue that affects your life and that could be investigated with a computer simulation.

Student answers will vary.

2. What background knowledge would you need to create the simulation?

Student answers will vary, but should include an understanding that simulations are based on data and mathematical algorithms as well as an understanding of the basic science behind what the students would investigate.

3. Define the system that the computer simulation would model. What basic components of the system would the simulation include? List your simulation's variables and describe the scientific relationships or principles that you would incorporate in your simulation.

Student answers will vary.

4. What variables would you test, and what is the simulation's output? How would you test the effectiveness of your simulation?

Student answers will vary. Students should describe how they would manipulate the variables to gather useful data. To test the effectiveness of the simulation, students might mention that they would compare the results of their simulation with related historical data similar to what the scientists did as described in the Science News *article.*

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Student Discussion Worksheet

Directions: Answer the first set of questions as directed by your teacher, then read the online *Science News* article "Greece's Santorini volcano erupts more often when sea level drops." Answer the last two sets of questions on your own. A version of the article, "Sea level dips spur volcanic eruptions," appears in the August 28, 2021 issue of *Science News*.

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2. What are the benefits of using a computer simulation? When might it be necessary?

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4. What is a visualization? How do visualizations differ from simulations?

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