SCIENTISTS IN THE FIELD

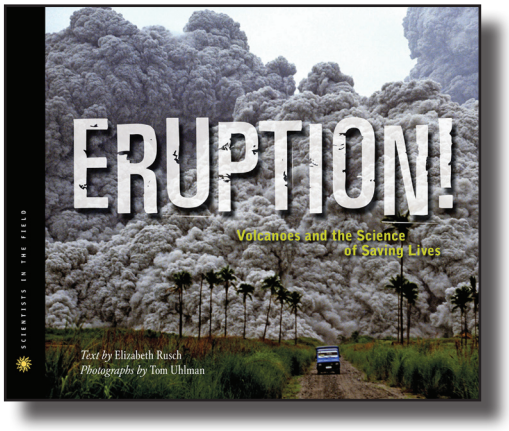
WHERE SCIENCE MEETS ADVENTURE

DISCUSSION AND ACTIVITY GUIDE

Eruption! Volcanoes and the Science of Saving Lives
By Elizabeth Rusch Photographs by Tom Uhlman

About the Series

Eruption! Volcanoes and the Science of Saving Lives is part of the award-winning Scientists in the Field series, which began in 1999. This distinguished and innovative series examines the work of real-life scientists doing actual research. Young readers discover what it is like to be a working scientist, investigate an intriguing research project in action, and gain a wealth of knowledge about fascinating scientific topics. Outstanding writing and stellar photography are features of every book in the series. Reading levels vary, but the books will interest a wide range of readers.



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About the Book

Humans have lived next to volcanoes for thousands of years despite the fact that when volcanoes erupt, humans suffer. Scientists studying volcanoes have learned a great deal about them, especially the many detectable warning signs leading up an eruption. A group of scientists banded together to form the first and only international volcano crises team, the Volcano Disaster Assistance Program or VDAP, hoping to predict eruptions and save lives. *Eruption!* chronicles the work of an early member of the VDAP team, Andy Lockhart, and the efforts of the team to accurately forecast eruptions and the many problems involved.

About the Author

Elizabeth Rusch has written about robots, crayons, exploding volcanoes, musicians and inventors—anything that catches her interest! She didn't always write for kids, she started her career by writing about kids for *Teacher* magazine, an award-winning magazine for teachers. Her books for children, including *The Mighty Mars Rovers,* another Scientists in the Field book, have won many awards, including an Orbis Pictus Honor and an NSTA Outstanding Trade Book designation. She lives in Oregon, where there are lots of volcanoes!

About the Photographer

Tom Uhlman has taken the photographs for many books, including ones about the Underground Railroad and our solar system, but he especially loves to photograph nature. He has worked on two other Scientists in the Field books, *The Bat Scientist* and *Emi and the Rhino Scientist,* both with his wife, the author Mary Kay Carson. He lives with Mary Kay in Cincinnati with their dog, Ruby.

Pre-Reading Activity

Pass out samples of igneous rocks (granite, quartz, feldspar, mica, obsidian), sedimentary rocks (shale, sandstone), and metamorphic rocks (marble, quartz-

ite, slate). Review the way these rocks are formed. Pass out some local rocks and try to place them in the correct category.
If you can obtain some pumice stones, have students predict whether or not rocks float or sink (which should have most students rolling their eyes at the question—of course they sink). Fill a container with water. Drop in several of the local rocks and any quartz or granite or sandstone and watch them sink. Then drop in the pumice stone. Why does the pumice stone float?

Take a look at the long-range weather forecasts from *Farmer's Almanac* and other sources. Would anyone use these predictions for planning purposes? Now look at short-term weather predictions (forty-eight hours or less). How accurate are these and what value do they have for planning purposes? Discuss how difficult it can be to predict the weather, even if you are a trained meteorologist. Discuss the challenges scientists might likewise face in predicting volcanic eruptions.

Discussion Questions

Yogyakarta is a city of up to 500,000 people, which is about the same range of population as Long Beach, Atlanta, Miami, or New Orleans. What would be the financial and social ramifications of ordering cities of this size to evacuate? Keep in mind Andy Lockhart's quote on page 9: "'*Evacuations hold their own dangers,' Andy explained. 'Very old people, very young babies, and very sick people can suffer and even die from the stress of an evacuation.*'"

Lockhart's team also worries about the impact of making a mistake: "*Andy and his colleagues knew that most people are only willing to be evacuated once. If nothing happens, locals might ignore future warnings.*" (p. 9) Given tight budgets and the difficulty of the task, does it make more sense to fund aid after a disaster or fund disaster prevention? Why is it easier to fund disaster aid than disaster prevention?

Satellites provide information about sulfur dioxide emissions, temperature, location of ash clouds, direction of wind, the amount of gasses, and more. Communication technology allows immediate release of information to concerned parties. Have we made enough advances in technology to change laws concerning hurricane, earthquake, volcano, or other weather-related evacuation procedures? Should people be legally required to evacuate? Should places prone to volcano damage have federal standards in place that determine where buildings should be placed and how they should be constructed? Is there a limit to how many times our government should rebuild and repair damage caused by natural disasters?

Why are the volcanoes in some areas more dangerous than those in other areas?

Many towns around the world are close to volcanoes. When a volcano is dormant, it is easy to forget how dangerous it is. The city of Armero was forty-five miles from Nevado del Ruiz and when it erupted in 1985, and the surging volcanic mudflows killed 23,000 people. Mt. Vesuvius is five km from the town of Pompeii, and the eruption in 79 AD killed 16,000 people. Use a local map and locate places that are 50 miles from your school and places that are 3 miles away. If one of those locations were a volcano, would you be concerned?

Pyroclastic flows can travel 100 miles per hour and volcanic mudflows or lahars can travel 50 miles per hour. If a volcano was 5 miles away how quickly would a pyroclastic flow or a lahar reach your town following an eruption? How fast can a person travel on foot? How much time would it take to get everyone in your neighborhood and your town to safety?

Applying and Extending Our Knowledge

On page 14 the volcanoes on Hawaii are described as ones that would produce "slowly bubbling lava." Other volcanoes, however, produce "pyroclastic flows" of incredible destructive power. While there are many excellent books and online resources for understanding the geology behind this book, a great source for activities is the book by Matthys Levy and Mario Salvadori, *Earthquakes, Volcanoes, and Tsunamis: Projects and Principles for Beginning Geologists* (an excellent complement to *Eruption!*). Many of the activities below are also found in Levy and Salvadori's book.

- Build a mound of sand to resemble a mountain. Place a film canister inside the mound so that the opening of the container is level with the top of the "mountain," forming a "crater." In the container place about a half-teaspoon of baking soda, some liquid soap, and (make sure to add this last) red wine vinegar. Students should be able to see "slowly bubbling lava" flow down the side of the mountain.

- To demonstrate more of a "pyroclastic flow," repeat the above procedure, but this time quickly cap the film canister and have ready some sand to quickly pour over the lid (it only takes seconds for the lid to blow off). You may wish to do this as a demonstration, and please make sure that you demonstrate proper safety steps by wearing safety glasses and a lab coat (this experiment can be messy). We recommend practicing this experiment without students several times to ascertain how much baking soda and red wine vinegar to use for the safest and most effective demonstration.

- A smoking volcano can be demonstrated by making a hole at the bottom of the mountain and inserting an air tube up to the top. The smoke can come from dry ice or burning kindling over moist paper. Please observe careful safety procedures for using dry ice or for building a fire. This activity may best be suited for doing outside the classroom.

- And don't forget that the way in which gasses contribute to volcanoes can be very easily demonstrated by simply shaking a carbonated beverage that is tightly capped and then by slowly unscrewing the cap. Most of us will not need the reminder that this can be very messy!

Common Core Connections

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

There are several different types of volcanoes.

- Have students research the different types of volcanoes and build or draw them.

- Have students show online pictures or videos of the various types of volcanoes, including any videos showing eruptions.

- Distribute map templates of the world and have students locate active volcanoes. Students should annotate the map to indicate the type of volcano, dates of its most recent eruption, and predictions of when it will erupt next.

Common Core Connections

RH.6-8.7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
RI.6.7. Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

According to the text, earthquakes function as one of the earliest clues that a volcano is getting ready to erupt. Since volcanoes tend to be located around the edges of tectonic plates, it's useful to learn about how the plates grind up against each other. To better understand these plates, try this demonstration from the Levy and Salvadori book, mentioned above:

- Lower an egg into boiling water, turn the heat down, and keep it in the water for about 7 to 9 minutes. Put it under cool water. The egg should NOT be hardboiled. Gently tap the egg against a flat counter, creating various "plates" on your egg planet. You should have a variety of plates that have a variety of sizes. Now squeeze the egg between two fingers and observe what happens to the various plates.

Common Core Connections

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

There are many online sources describing volcano-warning systems. Basically these warning systems state that the volcanic risk is normal, slightly dangerous, more dangerous, or very dangerous. The systems are color coded from green to yellow to orange and up to red. But how does this warning system get tied to the level of danger involved with a potential eruption?

- Have students investigate the USGS interactive volcano map (volcanoes.usgs.gov) and examine which volcanoes have higher warning colors. Then have students go to www.volcano.si.edu and research what is happening at

the volcanoes with elevated warning colors.
- What is the volcano physically doing that causes the color categories to change?

Common Core Connection

RH.6-8.7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

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GPS devices locate precisely where various features exist on a volcano, using longitude and latitude lines. These measurements function as the guides that allow the USGS scientist Dan Dzurisin to monitor precisely where the ground swellings on Mount St. Helens are located.

- Find the longitude and latitude of your school to the nearest degree.

- Using Google Maps, zoom in to the location of your school. Print out maps for students and have them insert and label a grid showing the precise location of the classroom.

- If your classroom has a document camera, use this tool to share several of the students' maps to show that each student should have the exact same coordinates (and to explain the factors that cause any errors).

- Share the exact GPS location (which can be found online through a longitude latitude search: www.findlatitudeandlongitude.com).

Common Core Connections

RH.6-8.7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

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On page 17 in the sidebar, "Sniffing Out the Gas," we learn that geologists search for at least three kinds of gases: carbon dioxide, hydrogen sulfide, and sulfur dioxide. The more gas, the larger and more explosive the eruption.

- Have students make models of each of the different gas molecules. Create flash cards for each molecule explaining its composition and its dangers (to people). Describe the gas's reactions to water or air or to other gases.

- Research how much of these gasses cause scientists to elevate the warning system colors.

Common Core Connections

RH.6-8.7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

RI.6.7. Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

Chapter 5 is entitled "Volcano Training Camp." In this chapter, the point is made that volcanoes do not operate according to a convenient schedule. It is entirely likely that someday many volcanoes could erupt simultaneously.

- What makes a good volcanologist in the first place? Go through the book and make a checklist of skills and knowledge one would have to have in order to be on the VDAP team.

- Andy says that to be effective, knowledge of the local area and the local people is essential. Discuss why knowing the area and the people would make a local volcanologist more effective than one from another country.

- What kinds of information, and from what sources (government officials or scientists, for instance), will people rely on when deciding whether or not to evacuate? Make a chart with these pieces of information and sources, listing them from most to least reliable.

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Common Core Connections

CCSS.ELA-Literacy.RI.6.1 Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

CCSS.ELA-Literacy.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Other Websites to Explore

U.S. Volcano Disaster Assistance Program
volcanoes.usgs.gov/vdap
(Official site of the U.S. Volcano Disaster Assistance Program, which provides information on the program and locations where the team has provided assistance.)

Smithsonian/USGS Weekly Volcanic Activity Report
www.volcano.si.edu/reports/usgs
(Cooperative project of the Smithsonian and the U.S. Geological Survey listing volcanic activity during each previous week.)

U.S. Geological Survey—Volcano Hazards Program
volcanoes.usgs.gov
(Site of the U.S. Geologic Survey that provides information on volcanic activity in the United States, alerts, maps, and general information on volcanoes.)

Further Reading

S.V.
"Volcanoes and Earthquakes." Encyclopedia Britannica, 2011.
Latta, Sara L. *Lava Scientist: Careers on the Edge of Volcanoes*. Enslow, 2009.
Levy, Matthys. *Earthquakes, Volcanoes and Tsunamis: Projects and Principals for Beginning Geologists*. Chicago Review Press, 2009.
Prager, Ellen. *Earthquakes and Volcanoes*. Chelsea House, 2009.
Spilsbury, Louise and Richard Spilsbury. *Violent Volcanoes*. Heineman, 2010.

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