Science - Volume 1 - Version 11

CARDINAL COMPASS - NO. 1 • HANDS-ON LEARNING • WITH CARL THE CARDINAL

Volcanoes

What they are. Why they erupt. What happened at Pompeii. And three experiments you can build safely at home.



A volcano is an opening in Earth. Hot melted rock, gas, and ash can come out of it.

Read together | Build together | Adult with you for every experiment



Meet Carl - Volcano Carl

Carl the Cardinal is your guide. For volcanoes, he wears goggles and a vest. He holds a pencil and a notebook. His green neckerchief and gold compass medallion stay on. Color this same Carl on the last page.

How to use this book: Pages 2-4 tell the story. Page 5 is safety. Read it first. Then do the three builds on different days. Finish with the questions. Color Carl at the end.

Keep a notebook near you. Write what you guess. Write what you see.

You will need, for all three experiments: baking soda, white vinegar, dish soap, red or orange food coloring, a small empty plastic bottle, a tray with a rim, air-dry clay or play dough, honey, cooking oil, two small trays or cookie sheets, books, a clear box or tub, slightly damp play sand in different colors, small toy houses or blocks, a soft paintbrush, safety goggles, measuring cups and spoons, a timer, a ruler, and a notebook. **Optional cooked dough, made by a grown-up only:** flour, salt, vegetable oil, cream of tartar, and cold water, plus a saucepan and a spoon. **Optional:** a piece of purchased pumice for page 13. The book works without it.

What is a volcano?

A volcano is an opening in Earth. Hot rock, gas, and ash can come out of it.

Magma is hot, melted rock under the ground.

Lava is magma that has reached Earth's surface.

Volcanic ash is made of tiny pieces of rock and volcanic glass. It is not soft like campfire ash.

Viscosity tells us how easily a liquid flows. Honey flows less easily than water.

How can hard rock melt?

Rock can melt if it gets hotter. Rock can also melt if the push on it gets smaller. Deep rock is pushed hard. That hard push helps keep it solid. Water deep in Earth can help rock melt too. Often, only part of the rock melts.

Why does a volcano erupt?

Pressure is a push. As magma rises, the pressure around it can drop, and gas bubbles can grow. Magma can reach the surface through an opening or crack. Then the volcano erupts.

Some eruptions send out flowing lava. Other eruptions blast ash and rock into the air.

Parts to find in the picture

Magma chamber - a pool of magma under the ground.

Pipe - the path magma takes up.

Crater - the bowl at the top.

Lava flow - lava running down the side. Real lava is very, very hot. It can glow.



Follow the orange path. It goes from the magma chamber, up the pipe, and out of the crater.

Volcano shapes tell a story



Left: wide and flat. Middle: tall and steep. Right: a slow, round dome.

Runny lava spreads far. It can build a wide, flat volcano. Thick lava does not spread far. It piles up near the top. You will race thick and thin liquids on page 9.

Pompeii: the town the ash kept



Pompeii long ago: shops, homes, baths, and a fountain. Mount Vesuvius stands behind the town.

Long ago, **Pompeii** was a busy Roman town in what is now Italy. Thousands of people lived there. A green mountain stood near the town. Its name was **Mount Vesuvius**.

Vesuvius had been quiet for a very long time. Many people did not know it could erupt. They did not expect an eruption this big.

In the year **79**, Vesuvius erupted. A Roman writer named **Pliny** saw the cloud from far away. He wrote letters about what he saw. His letters help us learn. Rocks, buildings, and things left in the town help us learn too.

Day 1
Ash and **pumice** shot high into the sky. Pumice is light rock full of tiny holes. It fell like rain for hours. It piled up on roofs. Some roofs broke. Many people left the town at this time.

Night and Day 2
The tall cloud fell down. A **pyroclastic surge** moved over the land. A pyroclastic surge is a fast-moving cloud of hot gas and ash that travels along the ground. Many people in Pompeii died.

After
Layers of pumice and ash covered the town. Pompeii stayed hidden for more than 1,600 years.



The tall ash cloud and the low cloud. Both shapes matter in this story.

A big surprise: Lava did not flow into Pompeii. No river of lava ran through its streets.

The ash cover was part of a sad event. Still, the cover kept many things safe for a long time. Today we can see streets and homes. We can see wall paintings, pots, tools, and shops. These things tell us how Roman people lived, worked, and ate. Slow, careful digging helps us read those clues. Keep one question in mind: what covered Pompeii? You will think about it again on page 11.

Watching a volcano: Mount St. Helens

Pompeii had no warning tools. This true story is different. It happened in the **state of Washington**, in the United States, in **1980**. Scientists watched this mountain for weeks before it erupted, and their warnings helped many people get out of the way.

March 1980 - the mountain wakes up

Mount St. Helens had been quiet since 1857. In March 1980, small earthquakes began under the mountain. An **earthquake swarm** is a group of many small earthquakes in one place. Hundreds were recorded. On March 27, a small steam eruption dusted the top with ash.

Watching and warning

Scientists from the **U.S. Geological Survey,** called the USGS for short, came to watch. They measured the shaking and the ground itself. The north side of the mountain was bulging outward as magma pushed up inside it. The bulge grew about **85 feet in 20 days.** The USGS warned that a big eruption was likely.

May 18, 1980 - the big eruption

At 8:32 that morning, a stronger earthquake shook the mountain. The bulging north side slid away in a **landslide,** a sudden slide of rock and earth down a slope. It was the largest landslide ever recorded. Losing that side took the pressure off the magma, and hot gas and ash blasted out sideways. A sideways blast of hot gas and ash is called a **lateral blast.** It flattened forests as far as 19 miles away. Fifty-seven people died.

Three signs, plainly told

- **Shaking.** A **seismometer** is a tool that measures shaking in the ground. The shaking came in swarms, and it did not stop. More than 10,000 earthquakes were recorded in the two months before the eruption.
- **Swelling.** The watchers measured the same places again and again. The north side kept moving outward, a little more every day. Ground that swells is ground with something pushing under it.
- **Small eruptions first.** Steam and ash came out of the top for weeks before the big day. Small eruptions can be a warning that bigger ones may follow.

How the watchers did their work

The watchers could not run an experiment on a real mountain. They could only watch, measure, write things down, and compare week by week. That is the careful watching you practice in this book. When the signs grew stronger, they said so plainly, even though they could not name the day.

Why the warnings mattered: No one could say the exact day or hour, and the scientists said so honestly. But the shaking and the bulge showed the mountain was dangerous. Leaders closed the area closest to the mountain, and the people who lived there left. People who had visited their cabins the day before were ordered to leave by nightfall, and they did. Because so many people were already out of the way, far fewer were in the path of the blast. Careful watching, honest warnings, and leaving when told saved lives.

What would you do?

Imagine your family lives near a quiet mountain. Scientists say the ground is shaking in swarms and the side of the mountain is swelling, but they cannot name the day. Would you pack and stay with family in another town for a while? What would you take with you? Talk about it with your grown-up. **One part is not a choice:** if leaders order families to leave, your family follows the evacuation order and leaves. An evacuation order is an instruction to obey, not an idea to vote on.

BEFORE ANY EXPERIMENT

Safety first - read this with a grown-up





Goggles on. Volcano on a tray. Grown-up right next to you. Stand to the side, not over the top.

Rules for every build

- **A grown-up stays with you** for every experiment. If the grown-up leaves, stop and wait.
- **Every person who watches up close wears goggles.** Stand to the side. Do not lean over the top.
- **Never taste the materials.** Not even a lick. Once a thing is for science, it is not food. Wash your hands before and after.
- **Never close a bottle while it is fizzing.** The gas needs a way out. A closed bottle can pop.
- **The grown-up takes the cap off first and puts it away.** Keep the bottle opening clear and open for the whole build.
- **Work on a tray with a rim.** Keep pets and small children back.
- **No fire in the experiments.** The experiments use no heat, and nothing is lit or burned. The only heat in this book is separate from the experiments: if you choose the cooked dough on page 6, a grown-up cooks it alone on a stove, away from the model, before the build begins.

Good scientist habits

- **Guess first.** Say what you think will happen. A wrong guess still helps you learn.
- **Change one thing at a time.** Then you can tell what made the change.
- **Wipe spills fast.** Foam and honey can be slippery.
- **Tell a grown-up at once** if something gets in your eyes. Rinse eyes with clean water.
- **Keep dust down.** Use damp sand for the dig. Put it down gently. Never blow on it.
- **Clean up the right way.** A small amount of watery vinegar-and-baking-soda liquid can be mixed with lots of running water and rinsed away, if that is okay where you live. Sand, clay, dough, oil, honey, and all solids go in the **trash, not the sink**. They can block pipes. Ask a grown-up about local rules.

EXPERIMENT 1 - PART 1

Build your own volcano

Question: Can gas bubbles push foam up and out of a mountain? What does this model show well? What does it not show?
Time: About 30 to 45 minutes to build. Then about 10 minutes to erupt. Air-dry clay may need time to harden. **Mess:** Medium. The tray helps a lot.

You will need

- 1 small empty plastic bottle, about 500 mL
- A tray or shallow box with a rim
- For the cone, pick one: air-dry clay, store-bought play dough, or cooked dough (box below)
- A funnel, if you have one
- If you like: small toy trees or houses
- Baking soda and white vinegar
- Dish soap and red or orange food coloring
- Measuring cups and spoons
- Safety goggles for every watcher
- **For cooked dough only:** 2 cups flour, 1 cup salt, 1 tablespoon vegetable oil, 2 1/2 teaspoons cream of tartar, 2 cups cold water, a saucepan, and a spoon

Grown-ups only: make the cooked dough first, away from the model

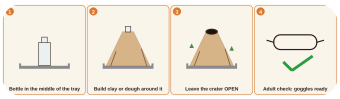
Skip this box if you use clay or store-bought play dough. Raw flour is not safe for crafts, so this dough is cooked first. Do not use a home dry-flour heat treatment.

A grown-up does this alone, in a saucepan, away from the bottle, the tray, and the model. Mix the flour, salt, vegetable oil, cream of tartar, and cold water in the saucepan. Cook over medium heat for about five minutes, stirring all the time, until it looks like mashed potatoes. Let it cool fully off the heat. Only when it is fully cool may children knead it and build with it.

No tasting. Wash hands and clean surfaces when you finish. Keep dough away from pets. **Never put the plastic bottle, the tray, or the built volcano in an oven or on a stove.** This dough is a soft modeling material, not a baked shell.

Build it - step by step

1. **Grown-up first:** Take the cap off the bottle and put it away. Do not use the cap in this project.
2. **Set the bottle in the middle of the tray.** This bottle is the pipe. Magma would rise through a pipe like this.
3. **If you use cooked dough, wait for the grown-up box.** The dough must be fully cool before anyone kneads or builds with it. Then shape the soft dough around the bottle.
4. **Build the mountain.** Press clay or dough around the bottle. Make a wide bottom. Make a narrow top. Keep the volcano on its tray.
5. **Keep the opening clear.** Do not cover the top of the bottle. That open top is the crater.
6. **Add details if you like.** Pull a fork gently down the sides to make ridges. Set toy trees or houses on the slopes.
7. **Know your cone material.** Cooked dough makes a soft same-day cone. It needs no air-drying before you erupt, but it is not a durable painted display. It is not waterproof or permanent, and wet dough may soften and need reshaping. Play dough is soft too. For a firmer model, use air-dry clay and follow its package's curing instructions. Repeated wet eruptions can still damage it.
8. **Draw your volcano.** In your notebook, draw the mountain. Label the bottle *pipe* and the top *crater*.

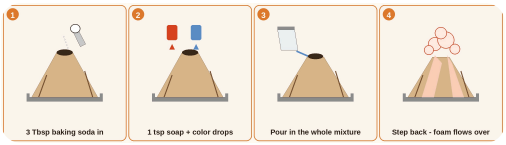


The build at a glance: bottle, cone, open crater, grown-up check.

Grown-up check: Cap put away. Opening clear. Volcano on the tray. Goggles ready. Towel near by. Then turn the page.

EXPERIMENT 1 - PART 2

Erupt it - and watch like a scientist



Soda in. Soap and color in. Pour. Step back to the side. No cap, ever.

Erupt it - step by step

1. **Goggles on for every watcher.** Stand to the side of the tray.
2. **Spoon 3 tablespoons of baking soda** into the bottle.
3. **Add 1 teaspoon of dish soap.** Add a few drops of red or orange food coloring.
4. **Mix the liquid in a cup:** 1 cup of white vinegar plus 1/3 cup of water. This is the room-temperature mixture. Keep it on the counter.
5. **Guess out loud:** How high will the foam go? Which side will it flow down first?
6. **Pour the mixture in at once. Step back.** Watch from the side, not from above.
7. **First, tell what you saw.** Where did bubbles pop up? Did foam flow over the top? Which slope did it pick? What sound did it make? Write it down before you read the box below.

What happened - and what this model does not show

Baking soda and vinegar meet. They make a new gas called **carbon dioxide**. Bubbles fill the liquid. Soap traps the bubbles. The foam grows, climbs, and flows out of the open top.

What this shows: Gas bubbles can push up. Foam can rise and flow over an edge.

What this does not show: Real magma is hot melted rock. It is not foam. Foam is light and bubbly. Magma can be thick and heavy. A real volcano can also hold a lot of push inside. Your bottle stays open and safe. That is why you must never close it.

How the gas is different: In your bottle, the carbon dioxide is **new gas**, made when baking soda and vinegar meet. In a real volcano, deep magma already holds **dissolved gas**, mixed in so completely that you cannot see it. As magma rises and the push on it gets smaller, that dissolved gas is released as bubbles. It is not made new at that moment.

What truly matches, and where the model fails: In both, bubbles move material up and out. That is the honest match. Your foam is cool and runny, so it spills gently. Real magma is hot melted rock, hot enough to glow. Thick magma can trap its bubbles until it breaks out in a blast, like the sideways blast at Mount St. Helens on page 4. Your bottle is about 500 mL, the size named on page 6. A real chamber holds vastly more and can erupt for hours or days.

A model is a tool, not a copy

Scientists use models knowing they are not perfect. A good model shows one or two things truly and leaves the rest out. The honest questions are always the same two: What does this model show truly? What does it leave out? You have now answered both for your volcano. Keep asking them on the next page.

EXPERIMENT 1 - PART 3

Cool mix or room mix? Test the whole mixture

New question: Does the foam change if the **whole vinegar-and-water mixture** is cool? In this test, you do **not** change just the water. You test the full mixture, both times with the **same amounts**.

Make a fresh whole mixture for every trial

1. **Room-temperature trial:** Mix a fresh cup: 1 cup of white vinegar plus 1/3 cup of water. Leave it on the counter until you pour it. Make a new room mixture for Try 2.
2. **Cool trial:** Mix a fresh cup the same way: 1 cup of white vinegar plus 1/3 cup of water. A grown-up puts this whole cup in the fridge until it feels cool. Make and chill a new cool mixture for Try 2.
3. **Fresh for every trial.** Each trial uses fresh baking soda (3 tablespoons), fresh dish soap (1 teaspoon), and fresh drops of color, plus its fresh full mixture. Do not top up or re-use left-over mixture. **Between runs:** rinse the bottle with plain water and drain it upside down for a moment, then load the fresh soda, soap, and color.

Start and stop are the same each time. Start: Start the timer when you pour. **Stop:** Stop the timer when the foam stops growing. **Foam height:** stand to the side, never lean over the bottle. Stand a ruler beside the tray before you start, and read the foam height from the side. Note how far it flowed too.

Guess first. Write your guess in the table. Do each test **two times** if you can. Surprise results count too. They are real clues.

Test	My guess	Time: start to stop	Foam height and flow
Room mix - Try 1			
Room mix - Try 2			
Cool mix - Try 1			
Cool mix - Try 2			

Draw or write what you saw:
Draw the tallest foam. Or write: Which foam stopped growing first? Which foam grew tallest? What surprised you?

More testable questions - pick one if you like

- What happens with **no soap** at all? Guess first. Change only the soap.
- What happens with **2 teaspoons of soap**? Guess first. Change only the soap.

Clean-up: Scoop foam and solids into the trash. Only the watery left-over liquid may be mixed with lots of running water and rinsed away, if that is okay where you live. Clay and dough never go down the sink. See page 5. Wash your hands.

EXPERIMENT 2

Thick lava, thin lava - the great race



Honey creeps. Water races. That gap is viscosity.

Question: Does how thick a liquid is change how fast it flows and how far it gets? **Time:** About 20 minutes. **Mess:** Sticky. Work on a tray. A grown-up checks for honey allergy first. Cooking oil can stand in for honey.

You will need

Honey or cooking oil; colored water; 2 matching trays; books; tape; a timer; a ruler; 2 small cups.

Race it - step by step

1. **Set up the track.** Lift both trays on books, at the same tilt. Tape a **start line** near the top of each tray. Tape a **finish line** near the bottom.
2. **Measure the same amount:** 2 tablespoons of honey in one cup. 2 tablespoons of colored water in the other cup. If you use oil instead of honey, write **oil** in the table.
3. **Start:** Pour one liquid at its start line and start the timer at once. **Stop:** Stop the timer when the front of the flow hits the finish line.
4. **How to fill in the table:** If the liquid reaches the finish line, write down its time and leave the distance box blank. If it hasn't finished at 60 seconds, write 'Didn't finish' in the time box and measure how far it got from the start line.
5. **Race each liquid two times.** Wipe the tray between tries. Write each result below.

Race	Time to finish	Distance at 60 seconds if unfinished
Water - Try 1		
Water - Try 2		
Honey or oil - Try 1		
Honey or oil - Try 2		

First, what did you see?

Tell it or draw it before you read below: Which liquid finished first? If neither finished, which liquid went farther? Did any flow keep moving after the timer stopped?

What the model shows

Honey has **high viscosity**. It flows slowly. Water has **low viscosity**. It flows fast and far. On a tilted tray, neither one stays in a tall pile. Both keep spreading. So compare **time to finish** and **distance at 60 seconds if unfinished**, not piles. Real lava is different in one big way: **real lava cools and turns solid as it flows**. That cooling is what lets lava build lasting shapes.

EXPERIMENT 3

Bury a town - then dig it up





Brush gently. Do not grab. Carl wears his goggles for the dig. You wear yours too.

Question: How can ash and pumice cover a town? And how do scientists uncover a town without breaking the clues?

Time: About 20 minutes to bury. About 20 to 30 minutes to dig. **Mess:** Low. Damp sand makes very little dust.

You will need

A clear box or tub; low toy houses or low blocks; **slightly damp play sand in different colors** - one color for each layer; a cup; a soft paintbrush; a spoon; safety goggles; a notebook and pencil. A grown-up dampens the sand a tiny bit: damp, not drippy.

Bury it - step by step

1. **Build your town.** Set low houses or low blocks in streets at the bottom of the box. Draw a map of your town.
2. **Layer 1:** Use the cup to place damp sand of the first color over the town, about 1 cm deep. Pour low and slow, close to the town. Never blow on the sand.
3. **Layer 2:** Add damp sand of a second color, about 1 cm deep. Place it just as gently.
4. **Layer 3:** Add damp sand of a third color, about 1 cm deep. If rooftops still show, add more thin layers: use enough damp sand to cover the rooftops. Taller toys may still show after three layers. Look through the side of the box. You can see bands of color. Layers like these are called **strata**.

Now dig it up - step by step

1. **Change jobs.** Now you are the scientist. Put your map away. Pretend you do not know what is under the sand.
2. **Goggles on. Dig with the brush and spoon.** Work one layer at a time. Go slow. Brush sand down and to the side in small bits. Never blow dust away.
3. **Stop each time you find a thing.** Draw it, and write where it was and how deep.
4. **At the end, look at your map again.** What stayed whole? What moved? What would you get wrong if you dug too fast?

> **Link back to Pompeii:** At Pompeii, homes, shops, wall paintings, pots, and tools were found under the layers. Each thing tells part of the story of Roman life.

THINK DEEPER

Questions to talk, write, and wonder about

Take your time on this page. Pick the questions you like best. Talk about them. Write your best answer. Then check page 12. Guessing first helps the learning stick.

Start with the big one

1. **What buried Pompeii if lava never reached it?** Use pages 3 and 10 to help you. Think about what fell from the sky. Think about what moved along the ground. What clues could help you decide?
2. Many people left Pompeii on Day 1, while ash and pumice fell. Why do you think **leaving early** and **good warnings** matter so much when a volcano wakes up?
3. Long ago, many people near Vesuvius did not know the mountain could erupt. What signs might tell people today that a quiet volcano is waking up?

Think like a volcanologist

A volcanologist is a scientist who studies volcanoes and watches them for warning signs.

4. You find a very wide, flat volcano. What clue does its shape give about how its lava flowed long ago? Why does shape alone **not** tell you how dangerous its next eruption will be?
5. If you could put **three tools** on a sleeping volcano to watch it, what would you watch for? Shaking? Gas? The ground swelling up? Heat? Pick three and say why.
6. Volcanoes can break things. They can also make new land and rich soil for farms. Why do you think people still live and farm near Vesuvius today? Would you?

Think like an archaeologist

An archaeologist studies buildings and things people left behind, to learn how they lived.

7. Pliny wrote letters about the eruption. He watched from far away. What could he **not** see from far away? How do buildings, wall paintings, pots, and tools in Pompeii tell parts of the story that his letters do not?
8. Your dig worked best when you went slow and wrote things down. What clues are lost if someone digs up a buried town fast, just to find treasure?
9. If you could leave **one everyday thing** from your home for scientists to find in 2,000 years, what would it be? What would they learn about your life? What might they get wrong?

What would you do?

10. Read page 4 again. Scientists warn that a volcano near your town is waking up. They can see the shaking and the swelling, but they **cannot name the day** it might erupt, and no order to leave has been given yet. Your family must choose: stay home and keep watching for more signs, or pack up and stay with family in another town for a while. **What would you choose?** What facts from page 4 help you decide? What would you pack first? **Remember the fixed rule:** if leaders do order an evacuation, families follow the order and leave. That part is never a choice.

THINK DEEPER

Check your thinking

Answers to check - read after you try

Question 1: Pompeii was buried by what fell and flowed from Vesuvius, not by lava. Ash and pumice fell from the sky and piled up deep. Later, pyroclastic surges moved along the ground and added more layers. Layer on layer covered the town.

Question 4: A wide, flat shape is a clue. Its lava most likely was runny and spread far before it turned solid. But shape alone does not tell how the next eruption will go. The magma and its gas affect how it may erupt. Warning signs, like shaking, gas, and ground swelling, help scientists track changes.

Questions 2, 3, and 5-9 have no single right answer. Question 10 has no single right answer about leaving early, before any order is given. Its fixed rule is below.

More answers to check

From page 4: The first warning signs at Mount St. Helens were hundreds of small earthquakes in March 1980. Then the north side of the mountain bulged outward, about 85 feet in 20 days, as magma pushed up inside it. Scientists warned that a big eruption was likely. The closest area was closed, and many people left. That is why Question 2 matters: leaving early, while there is still time, is one of the best protections a warning can give.

What the watchers could not do: They could not name the exact day or hour. Honest warnings say what is known and what is not known. A warning can be worth obeying even when it cannot promise a day. That is the heart of Question 10. **The fixed rule:** if leaders order families to evacuate, families follow the evacuation order and leave. Disregarding an evacuation order is never a right answer.

From page 7: In both your bottle and a real volcano, bubbles can move material up and out of an opening. That is the honest match. The gas itself is different: your bottle makes new carbon dioxide when baking soda and vinegar meet, while a real volcano releases gas that was dissolved in the magma as the push on the rising magma falls. The model leaves out the heat of real magma, the strength of thick magma that can trap its bubbles until it blasts, and the size of a real mountain.

Words to keep

Word	What it means
Magma / Lava	Magma is melted rock under the ground. Lava is magma that has reached Earth's surface
Volcanic ash	Volcanic ash is made of tiny pieces of rock and volcanic glass
Viscosity	How easily a liquid flows. Honey flows less easily than water
Pumice	Light rock full of tiny holes. It can even float
Pyroclastic surge	A fast-moving cloud of hot gas and ash that travels along the ground
Strata	Layers set down one on top of the next. In undisturbed layers, the oldest is usually at the bottom
Volcanologist	A scientist who studies volcanoes
Seismometer	A tool that measures shaking in the ground
Landslide	A sudden slide of rock and earth down a slope
Lateral blast	A blast of hot gas and ash that bursts out sideways from a volcano

THINK DEEPER

Go further

- **Draw:** Draw your volcano from page 6 next to a real volcano. Label what matches and what does not.
- **Learn:** Pick one real volcano with a grown-up - Kilauea, Mount St. Helens, or Vesuvius today - and make a fact sheet.
- **Write:** Write a short letter as Pliny, or as a baker in Pompeii. Use three facts from page 3.
- **Test (optional, needs purchased pumice):** With a grown-up, drop pumice in water. Guess first: sink or float? Skip it freely - the book is whole without it.
- **Visit (online, with a grown-up):** Open the USGS Mount St. Helens page from the sources box below. Find a photo of the crater and the dome today. Draw what you see, and write one way it looks different from page 4.

One more true story: the dome that grew back

After the 1980 eruption, Mount St. Helens was not finished. Over the next six years, thick lava rose slowly into the new crater and piled up into a mound called a **lava dome**. A lava dome is a steep pile of thick lava that is too stiff to flow far. Scientists watched it grow the same careful way: measuring, writing down, and warning when the mountain stirred. The mountain from page 4 is still watched today.

Start your fact sheet here:
Pick a volcano from the Learn line above. Write its name and where it is. Write when it last erupted. Write one warning sign scientists watch for. Write one thing you still wonder.

Your next investigation: What question would you investigate next, and what evidence would you collect? What result would change your mind?

For grown-ups: tying the watching story to the builds

Page 4 is the history heart of this expanded edition. The same three habits run through every page of the book: watch closely, measure honestly, and write down what you really see. The foam build on pages 6 and 7 shows what gas can do. The race on page 9 shows why thick lava piles up into domes like the one in the story above. The dig on page 10 shows why slow, careful records matter. If your child asks why people obey a warning that cannot name a day, page 4 and Question 10 on page 11 are written to answer together.

For grown-ups: sources to explore together

USGS - How do volcanoes erupt? (eruption explainer):
https://www.USGS.gov/media/audio/how-do-volcanoes-erupt

Pompeii Archaeological Park - archaeology and excavations at Pompeii:
https://pompeiisites.org/en/comunicati/pompeii-archaeological-and-urban-regeneration/

University of California Agriculture and Natural Resources - how to make homemade playdough (cooked dough recipe):
https://ucanr.edu/site/uc-master-food-preservers-central-sierra/article/preserve-it-series-how-make-homemade-play

U.S. Food and Drug Administration - flour is a raw food and other safety facts:
https://www.fda.gov/consumers/consumer-updates/flour-raw-food-and-other-safety-facts

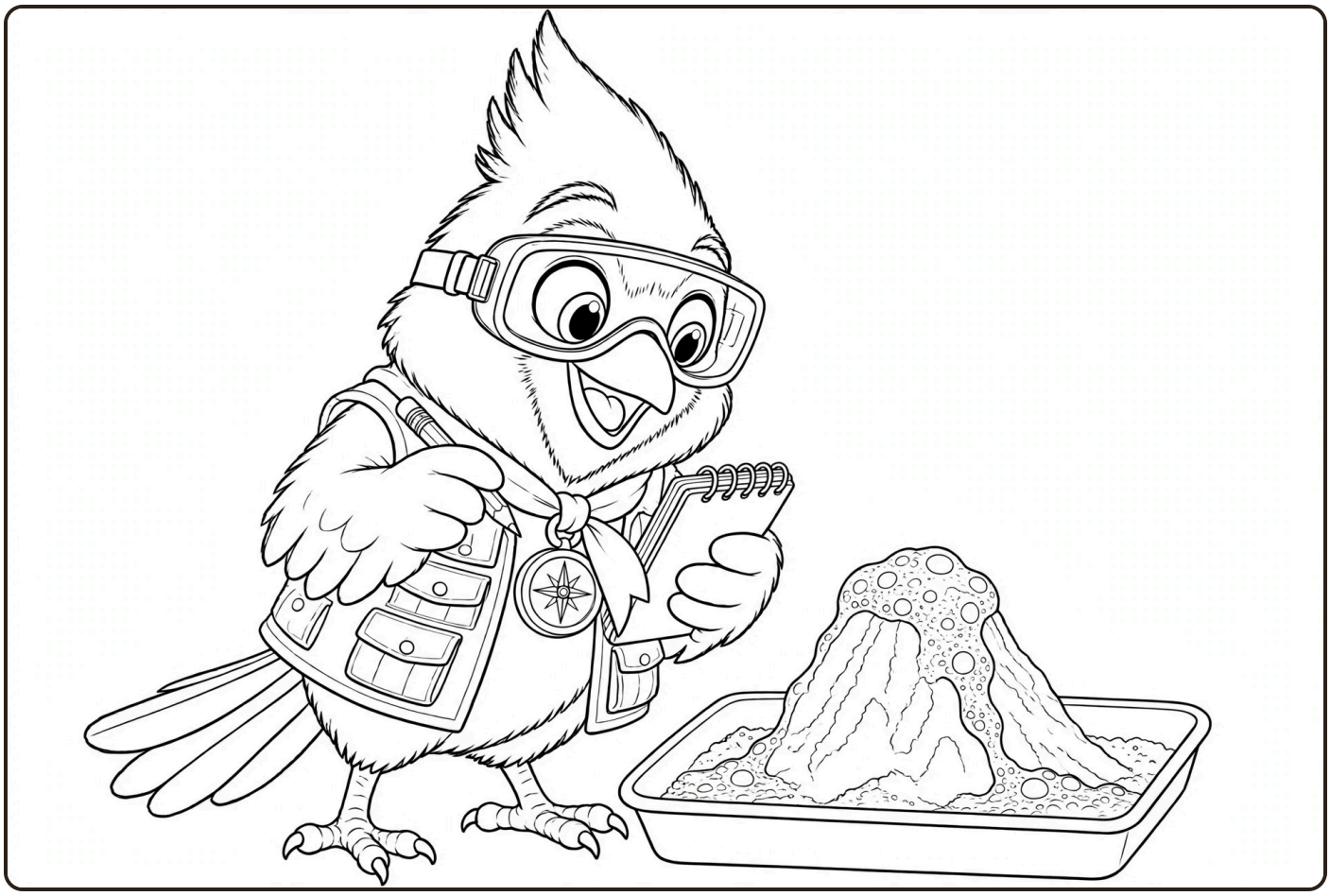
USGS - Mount St. Helens and the 1980 cataclysmic eruption (how scientists watched the mountain and warned people):
https://www.usgs.gov/volcanoes/mount-st.-helens/science/1980-cataclysmic-eruption

USGS - Volcanic gases and water (how dissolved gas leaves rising magma as the pressure falls):
https://www.usgs.gov/programs/VHP/volcanic-gases-and-water-include-chemical-signatures-magma

Coloring page: Volcano Carl

Print this page and color Volcano Carl. This is the same Carl as page 1, in the same pose, with the same gear.

Color guide: Feathers and crest bright red. Mask dark. Eyes amber-brown. Beak orange. Chest cream. Neckerchief green. Compass medallion gold, with a red and green star. Vest tan. Notebook brown. Lava orange and red. Or pick your own colors. There is no wrong way to color Carl.



Volcano Carl: goggles, vest, notebook, neckerchief, medallion, and one small volcano. Keep him with your science notebook.