Once Upon an Earth Science Book

12 Interdisciplinary Activities to Create Confident Readers

Jodi Wheeler-Toppen

NSTA press
National Science Teachers Association

Once Upon an Earth Science Book

12 Interdisciplinary Activities to Create Confident Readers

Once Upon an Earth Science Book

12 Interdisciplinary Activities to Create Confident Readers

Jodi Wheeler-Toppen

NSTA press
National Science Teachers Association
Arlington, Virginia

NSTA press®
National Science Teachers Association

Claire Reinburg, Director
Wendy Rubin, Managing Editor
Rachel Ledbetter, Associate Editor
Amanda O'Brien, Associate Editor
Donna Yudkin, Book Acquisitions Coordinator

Art and Design
Will Thomas, Jr., Director—Cover and Interior Design
All superhero art on pages 1, 11, 23, 29, 45, 55, 65, 75, 85, 97, 109, 123, 133, 151, and 163 courtesy istockphoto

Printing and Production
Catherine Lorrain, Director

National Science Teachers Association
David L. Evans, Executive Director
David Beacom, Publisher

1840 Wilson Blvd., Arlington, VA 22201
www.nsta.org/store
For customer service inquiries, please call 800-277-5300.

19 18 17 16 4 3 2 1

Library of Congress Cataloging-in-Publication Data
Names: Wheeler-Toppen, Jodi.
Title: Once upon an earth science book : 12 interdisciplinary activities to create confident readers / by Jodi Wheeler-Toppen.
Description: Arlington, VA : National Science Teachers Association, [2016] | Includes bibliographical references.
Identifiers: LCCN 2016007042 (print) | LCCN 2016016494 (ebook) | ISBN 9781941316092 (print) | ISBN 9781941316740 (e-book)
Subjects: LCSH: Earth sciences--Study and teaching (Middle school)--Activity programs. | Earth sciences--Study and teaching (Secondary)--Activity programs. | Geology--Study and teaching (Middle school)--Activity programs. | Geology--Study and teaching (Secondary)--Activity programs. | Oceanography--Study and teaching (Middle school)--Activity programs. | Oceanography--Study and teaching (Secondary)--Activity programs. | Curriculum planning.
Classification: LCC QE28 .W54 2016 (print) | LCC QE28 (ebook) | DDC 550.71/2--dc23
LC record available at https://lccn.loc.gov/2016007042

Contents

Contents

Acknowledgments

For Jon, Natalie, and Zachary

With special thanks to a wonderful team of teachers who field-tested activities from this book:

Donna Budynas
Hutchison School, Memphis, Tennessee

Matt Hackett
Delta Woods Middle School, Blue Springs, Missouri

Jodie Harnden
Sunridge Middle School, Pendleton, Oregon

Michelle Kester
Dike School of the Arts, Cleveland, Ohio

Karen Kraus
Delta Woods Middle School, Blue Springs, Missouri

Judy Strickland
Douglas County Schools, Georgia
National Institutes of Health

Chapter 6

Continents on the Move

Topics

- Plate tectonics
- Alfred Wegener
- Nature of science

Reading Strategy

- Chunking

Lesson Objectives: Connecting to National Standards

The following list shows the *Next Generation Science Standards* (*NGSS*) and *Common Core State Standards* (*CCSS*) supported by this activity.

NGSS: *Science and Engineering Practices*

- Analyzing and Interpreting Data
- Engaging in Argument From Evidence

NGSS: *Disciplinary Core Ideas*

- **ESS1.C.** The History of Planet Earth
- **ESS2.B.** Plate Tectonics and Large-Scale System Interactions

NGSS: *Crosscutting Concept*

- Cause and Effect

CCSS: *Literacy in Science and Technical Subjects*

- **CCSS.ELA-Literacy.RST.6-8.2.** Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
- **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).
- **CCSS.ELA-Literacy.WHST.6-8.1.** Write arguments focused on discipline-specific content.
- **CCSS.ELA-Literacy.WHST.6-8.2.** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Background

Plate tectonics is the primary theory that drives explanation in geology, but the idea that land masses drift around the Earth can sound as crazy to students as it did to geologists in the early 1900s. Spending time on the history and evidence of plate movement can help students understand this pivotal idea. In this chapter, students will consider some of Alfred Wegener's evidence for continental drift and read about what it took to challenge the prevailing views in geology.

Materials

- Magazine advertisement (1 per group)
- Set of southern Pangaea continents (1 per group)
- Envelopes or plastic sandwich bags

Student Pages

- Continents on the Move? (lab sheet)
- "Wegener's Bold Claim" (article)
- Seafloor Spreading (thinking visually)

Exploration/Pre-Reading

Before class, cut the magazine advertisements into about six pieces. Remove one piece so that students do not have a complete puzzle. Place each advertisement into an envelope. Also, cut out the southern Pangaea continents and a copy of the key for each group and place these in another envelope. The continents do not have to be cut perfectly along all dips and curves. Both sets can be used across multiple classes.

Begin by having groups try Part 1 of Continents on the Move?, in which they look for evidence that the pieces of a magazine advertisement come from the same page. This will help them think about what kind of evidence would suggest that the continents were once connected. Then have groups complete Part 2, in which they consider some of Wegener's evidence for continental drift.

Introduce the Reading. Tell students that they are going to read more about Alfred Wegener and the ideas he proposed. You may want to show them Greenland on a map and explain that, despite its name, it is a cold, icy island.

TEACHING TIP

If your students are comfortable with using claims and evidence, introduce this counterclaim in Part 1: *You can't know if the pieces came from one page because you don't have the complete page.* Help them rebut the counterclaim by asserting that their evidence is still valid, even if they do not have all possible information.

Reading Strategy: Chunking

To introduce the strategy, put the following sentence on the board:

Glaciers leave behind rock deposits as they move, and sometimes leave deep scratches in the bedrock.

Point out that this sentence, like many sentences in science writing, has a lot of ideas crammed into a short sentence. It might be difficult to understand all of the ideas at one time, but if students break the sentence into chunks, they can think about each piece individually.

Add slashes (/) to the sentence on the board so it reads like this:

Glaciers / leave behind rock deposits as they move, / and sometimes leave deep scratches in the / bedrock.

Talk them through the sentence, one section at a time. Start with the word glaciers. Ask, "What is a glacier?" Then look at the next section. The phrase "rock deposits" may be difficult. Point out to students that they can visualize an image of glaciers leaving bits of rock behind as they move.

Ask if anyone has questions about the glaciers leaving scratches. Have them visualize scratches in a rock. Would it be easy to scratch a rock? Would scratches be preserved for a long time? What kind of rock are the

scratches in? Make sure students know that bedrock is the solid rock under the dirt and loose rock we usually see.

When you are finished, summarize the information you have gathered from this sentence, saying something such as, "So, these ice masses drop rocks and boulders as they move. They even scratch the hard rock underneath the ground, leaving marks that people could find later."

Explain that chunking a sentence is like eating a pie. People cannot put the whole pie in their mouth at one time; everyone eats it bite by bite. When eating, some people will take bigger bites than others. Some people will need to break a sentence into more chunks than others, and that is okay. For this article, students can separate the chunks using slashes, like you did on the board. When they are reading something they can't write on, they can chunk it in their head or cover up the parts of the sentence they aren't thinking about.

Journal Question

Chunking is especially useful when you are reading long sentences full of new information. Think of a topic you know a lot about. Write a sentence that gives a lot of information on your topic. Use slashes to mark how your reader might chunk that sentence.

TEACHING NOTE
You may need to explain to students what happens at a scientific conference.

Application/Post-Reading

- Thinking Visually: Seafloor Spreading
- Writing Prompt: Imagine that you could go back in time and talk to the geologists at the conference where they mocked Wegener's idea. Explain to them how new evidence from the ocean and satellites supports the idea that continents can move.
  - Prewriting Questions: Jot down the types of evidence you want to mention in your speech. Think of an opening sentence that would introduce your ideas and a closing sentence to summarize your points. What science words will you want to include? What are some writing words you might use? (*therefore, in conclusion*)
  - Key Evaluation Point: The mountains in the ocean are made of young rocks where magma is seeping through gaps between the plates. Satellites can measure the movement of land on Earth.

FIND OUT MORE
To learn more about Wegener's life and theory, see
- McCoy, R. M. 2006. *Ending in ice: The revolutionary idea and tragic expedition of Alfred Wegener.* Oxford: Oxford University Press.

Continents on the Move?

Part 1: Look at the pieces of paper provided by your teacher. Do you think they were ever part of the same page?

Claim (circle one): The pieces of paper (were / were not) originally part of the same page.

Evidence:

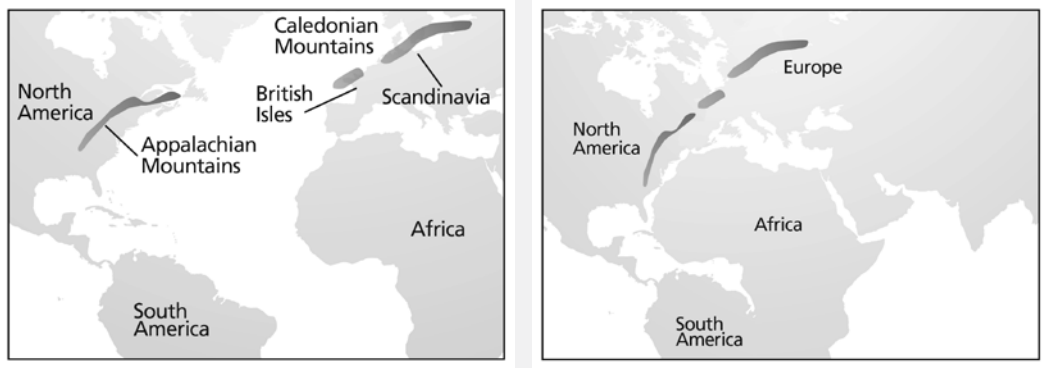
How does this evidence support your claim?

Part 2: In the early 1900s, a man named Alfred Wegener studied a variety of geological puzzles around the Earth. He wondered if they might all be clues to the past. Three of his puzzles are described below.

A. Mountain Ranges

The Appalachian Mountains are a very old mountain range that runs along the eastern United States. Mountains that are very similar in age and formation run through the British Isles and Northern Europe. There are no mountains in the ocean between them. Wegener wondered what would have crumpled the land into mountains in two places while leaving the ground beneath the ocean untouched. Look at the two maps in Figure S6.1

Figure S6.1. Mountains Running Through the British Isles and Northern Europe

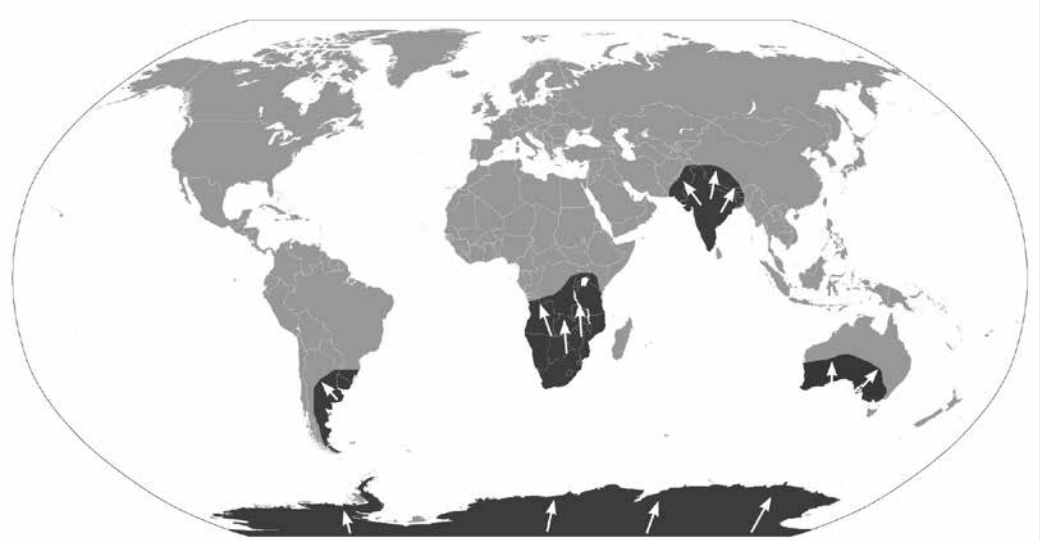


How does combining the continents solve the problem of how the mountain range could have formed?

B. Glaciation

As glaciers move across land, they leave scars and scratches in the rock that show the direction they are moving. Wegener was puzzled by the presence of glacial scarring in places that seemed too close to the equator to have ever been cold enough for glaciers. He also noticed that the scars all showed movement in the same general direction. Look at the map in Figure S6.2. Dark areas show where there is evidence of glaciers, and arrows show the direction of movement.

Figure S6.2. Glacier Movement



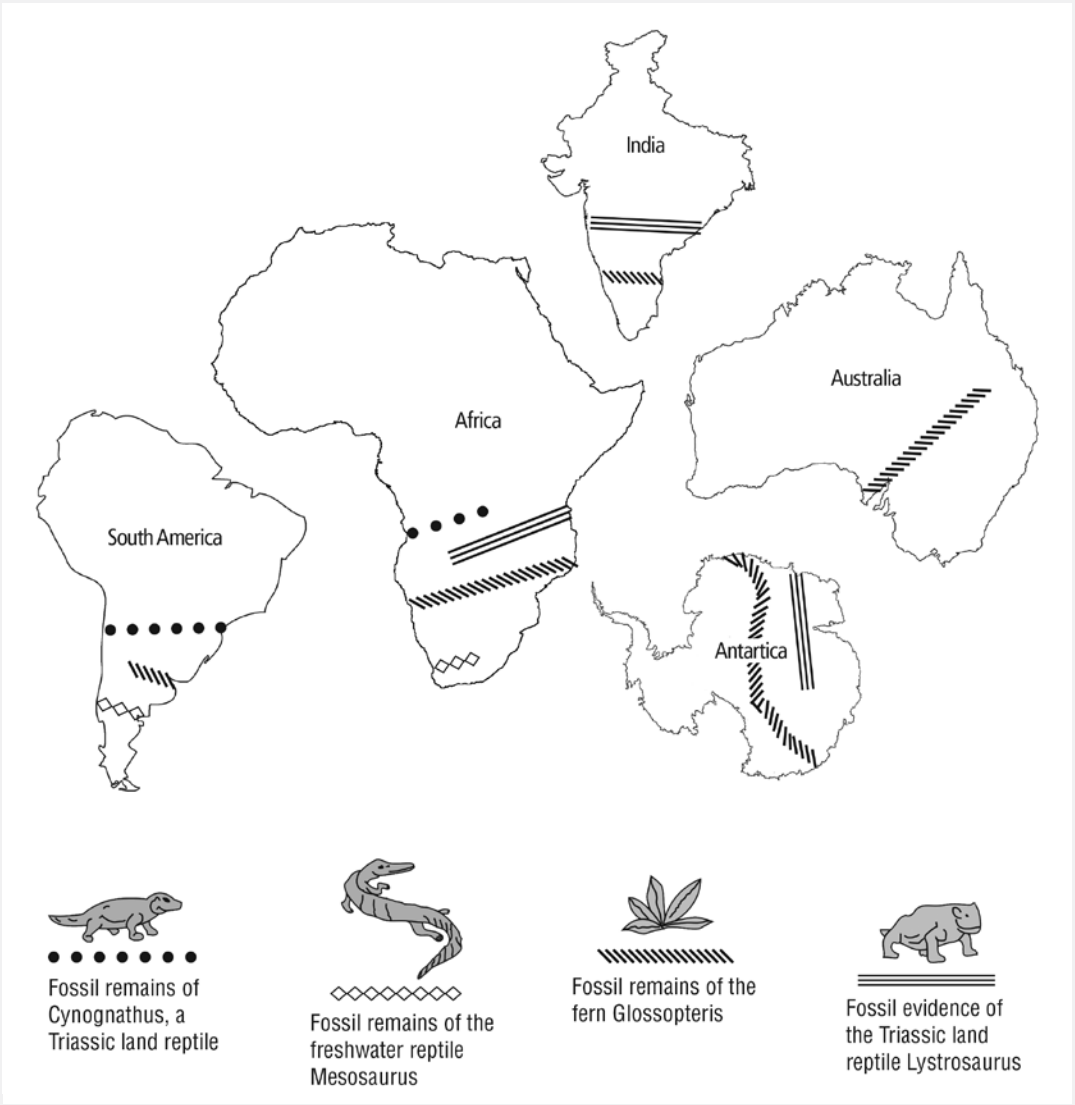
How could you arrange the continents to solve Wegener's two puzzles: that the areas with glaciers are far away from each other and that some of the areas with glaciers are very near the equator?

C. Fossils

A third puzzle had to do with the locations of fossils that dated back to about 225 million years ago. Take *Glossopteris.* It was a plant: it couldn't pick itself up and walk to new places. Its spores were fragile and wouldn't survive a long trip. Birds hadn't evolved yet, so there were no animals to carry the plant across the ocean. Yet collections of *Glossopteris* fossils are located on all of the southern continents. The same was true of several other fossils from that time period. Use the cutouts of the locations where fossils were found to find a possible arrangement of the land around 225 million years ago.

Draw or trace your shapes to create a diagram of the arrangement you come up with.

Fossil Puzzle



REMEMBER YOUR CODES
! This is important.
✓ I knew that.
X This is different from what I thought.
? I don't understand.

Wegener's Bold Claim

Alfred Wegener was puzzled. He studied climates—ancient climates, to be exact. One bit of information had bothered him for a long time. The parts of the world that had coal were not where they should have been. Coal forms in tropical areas where dead ferns and other warm-weather plants have been compressed into rock over millions of years. But Wegener knew that coal deposits were found in places too close to the Arctic to have ever been warm enough for tropical plants. There were even coal deposits beneath the frozen tundra in Siberia.

Glaciers bothered him, too. At about the same time that coal was forming in places it didn't belong, there seemed to have been glaciers in places they didn't belong. Glaciers leave behind rock deposits as they move and sometimes leave deep scratches in the bedrock. Wegener saw evidence of glaciers in places that were too hot for ice.

As he read the work of other scientists, he learned about other puzzles. The Appalachian mountain range started in North America, seemed to disappear at the edge of the ocean, and start up again in Europe. Identical fossils of plants and animals that could not swim across the ocean were spread across multiple continents. These fossils all dated from about the same time period. Later fossils from those areas were quite different.

Wegener suspected the continents had moved. But how could whole continents move? If he proposed such a thing, he would risk looking crazy.

_____

Pioneer or Daredevil?

Wegener was no stranger to risk. Even as he thought about his puzzles, he was off on daring explorations. At age 26, he and his brother set a hot air balloon record, staying aloft for more than two days. That sounds minor in today's world of easy air travel, but back then it meant hanging loosely above the Earth in a fragile wooden basket—with only a rough ability to navigate—and hoping that your balloon did not tear or break and send you plunging back to Earth.

Wegener worked on his continental drift theory over the long winter of 1913. He and his research partner were the first explorers to spend the whole winter in the center of Greenland. They wore thick coats (Figure S6.3). They built themselves a shelter out of plywood and packed it in snow for insulation. It was only about the size of a two-car garage, and they shared it with the five ponies that had hauled in their building materials. Survival was not guaranteed. On his previous expedition to Greenland, three of Wegener's colleagues had frozen to death on the trip home.

Figure S6.3. Thick Coat Worn by Wegener in Greenland

When he got home from Greenland, he got ready to share his ideas on continental drift. It was a good thing Wegener was tough.

Challenging the Hot Potato

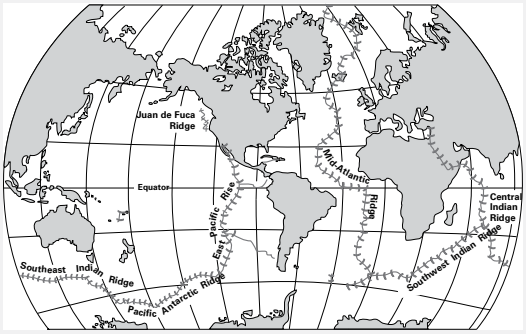
He wasn't the first scientist to wonder about the continents. Others had noted that South America and Africa look an awful lot like they should fit together. But Wegener was the first to compile evidence from several science areas and put forth the claim that, in fact, the continents had moved. In 1915, he published *The Origin of Continents and Oceans.* Among other things, it proposed that mountains were formed by continents crashing into each other and folding the Earth up.

Geologists were not impressed. Who was this climate scientist claiming to tell *them* about the history of the Earth? It's not that they had everything figured out. The current theory in geology was that the crust of the Earth was cooling and mountains formed because the land was wrinkling like the skin of a baked potato. Geologists knew their theory had a problem, because mountains should be everywhere instead of mostly at the edges of continents. But they were not going to let an outsider change their views. They also had a valid criticism of Wegener's idea. He couldn't figure out what force would be strong enough to propel the continents across the ocean floor. At a conference held to discuss continental drift, geologist after geologist took the floor to ridicule Wegener. For years, Wegener's idea was a joke among geologists, and comparing someone to Wegener was considered an insult.

Sea Floor Spreading

His evidence wasn't going away, however. And after World War II, a new piece of the puzzle was found. When governments were mapping the ocean floor in order to steer their submarines, they found enormous mountains that stretched across the middle of each ocean like the stitching on a baseball (Figure S6.4). The rocks that made up these mountains were some of the youngest on Earth. It appeared that the floor of the ocean was pulling apart, and magma from deep in the Earth was oozing up to form mountains. Suddenly Wegener's idea didn't seem so crazy. Only, it wasn't just continents moving around the Earth and having to plow through the ocean. The whole crust of the Earth was broken into plates that could slide, ever so slowly, into new places. As technology has improved, geologists have even confirmed plate movement using measurements from satellites in space.

Figure S6.4 Locations of Mountains Across the Ocean Floor

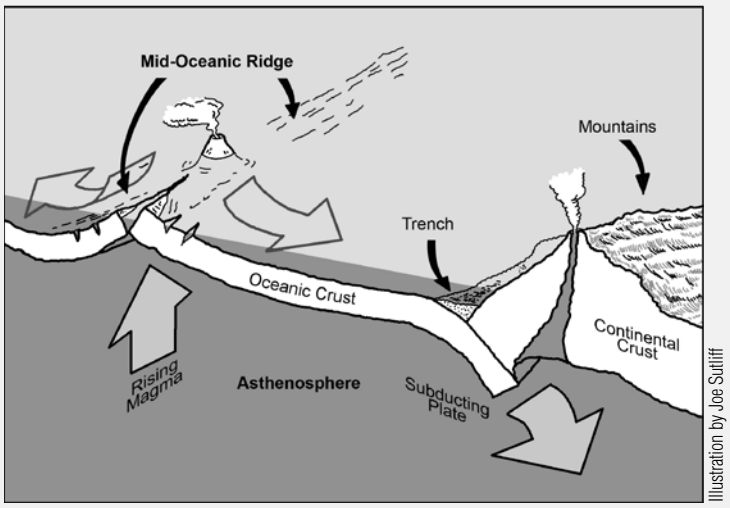


Wegener did not live to see his theory accepted. He continued researching and rewriting his book for the rest of his life. But he also poured himself into climate research in Greenland, and his work there was well accepted. In fact, he died there on his fourth expedition in 1931 when he was returning from having delivered supplies to friends who would have been stranded at their research post without enough food for the winter. His friends buried him in the snow and returned later to post a grave marker. Perhaps he is vindicated now, resting beneath the ice in Greenland as the entire North American plate crawls, centimeter by centimeter, toward the Pacific Ocean.

THE BIG QUESTION

Do scientists ever change their minds about how something on Earth works? What helped scientists eventually accept Wegener's claim?

Seafloor Spreading



Wegener's theory of continental drift has developed into the modern theory of plate tectonics. The diagram above shows the movement of plates in the ocean and at the border of an ocean and a continent.

Questions

1. Arrows in diagrams can have different meanings. This diagram has two types of arrows. Draw a line to match the arrow type with what it is doing in the diagram.

Thin black arrows	____ pointing to something important that you should notice
	____ showing the direction that something is moving
Large white arrows	____ giving the name of an object in the picture
	____ showing that one thing turns into something else

2. Draw your own arrow on the diagram to label where the newest rock is forming.

3. What kind of rock would you expect to find in the mountains of a mid-ocean ridge (sedimentary, igneous, or metamorphic)?

4. Oceanic crust is denser than continental crust. What happens to oceanic crust when it meets continental crust?

5. In this diagram, what two features form when oceanic crust meets continental crust?

Index

Page numbers in **boldface** type refer to tables or figures.

Once Upon an Earth Science Book

12 Interdisciplinary Activities to Create Confident Readers

Author Jodi Wheeler-Toppen has been in your shoes. An experienced science teacher, she knows what it's like to work with students who struggle to understand their science texts. *Once Upon an Earth Science Book* came about because she couldn't find a resource that shows how to integrate reading, writing, and Earth science—so she wrote it herself.

Practical and easy to use, *Once Upon an Earth Science Book* provides everything you need to boost students' skills in both science and reading. The book starts with advice on teaching reading comprehension strategies to middle school students. Then, the 12 content chapters give you

- hands-on science activities with engaging titles such as "Mountain Mayhem," "Oceans on the Move," and "Trash Soup";
- readings that cover important Earth science concepts and support the *Next Generation Science Standards*;
- writing activities that prompt students to connect what they did with what they read; and
- assessment exercises to give you feedback on what your students are learning.

Wheeler-Toppen, who also wrote NSTA Press's *Once Upon a Life Science Book* says, "As you and your students work through these lessons together, you will be able to watch their confidence as readers—and your confidence as a reading educator—grow."

PB275X2
ISBN 978-1-941316-09-2

Grades 6–8

NSTA press
National Science Teachers Association