

Texts *for* Close Reading™

# *Exploring* Earth's Structures





## Student Objectives

*I will be able to:*

- Read and analyze literary and informational texts about Earth's structure.
- Share ideas with my peers.
- Build my vocabulary knowledge.
- Conduct research to write a science fiction text.

# Tips for Text Annotation

As you read closely for different purposes, remember to annotate the text. Use the symbols below. Add new symbols in the spaces provided.

Symbol	Purpose
<u>underline</u>	Identify a key detail.
★	Star an important idea in the margin.
① ② ③	Mark a sequence of events.
○ magma ○	Circle a key word or phrase.
?	Mark a question you have about information in the text. Write your question in the margin.
!	Indicate an idea in the text you find interesting. Comment on this idea in the margin.

Your annotations might look like this.

15 The accuracy of scanning potential dig sites also improved. In the 1950s, archaeologists first began using instruments called magnetometers to measure magnetic properties below the Earth's surface. Variations in magnetism in the soil, for example, can help identify the presence of objects (artifacts) or areas where human activities, such as cooking, occurred. The results can be recorded and mapped to give an overview of a site for archaeological exploration.

16 Then, in the 1960s, lidar (light detection and ranging), which uses a combination of light pulses and radar, was attached to airplanes and used to scan for possible excavation sites. Later, in the 1970s, ground-penetrating radar was used to identify structures buried beneath the ground.

Notes

It's amazing what we can learn through technology!

How low do these planes fly?

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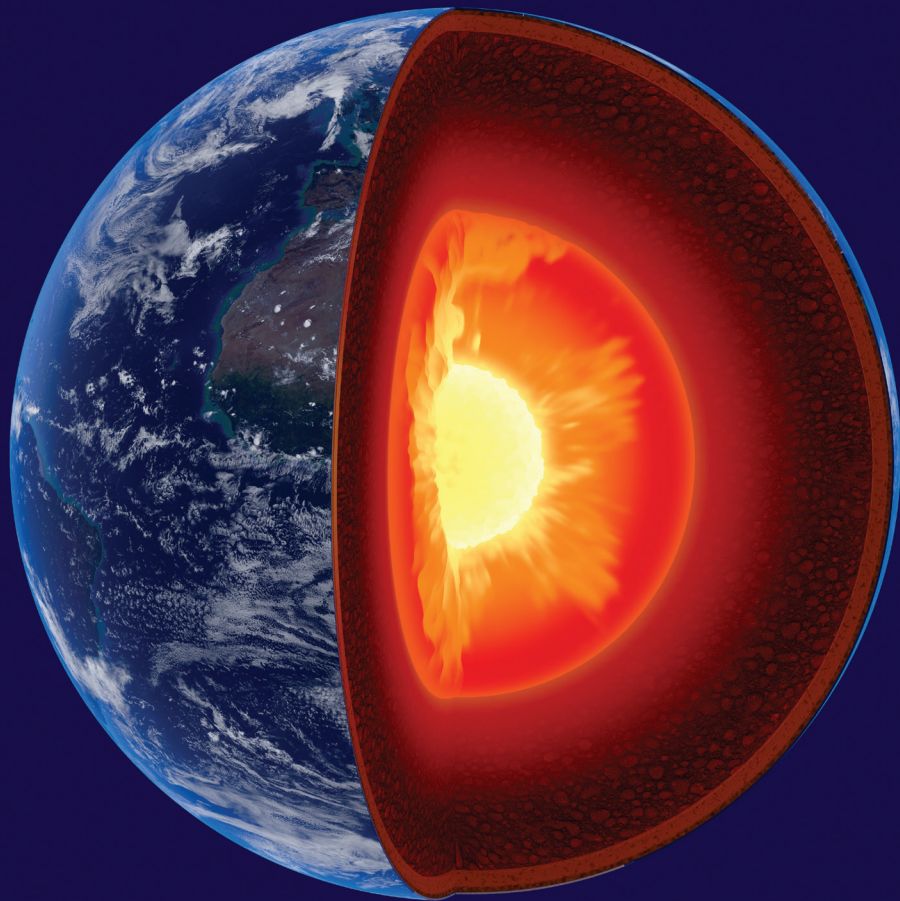


Essential Question

# How does Earth itself inspire human endeavors?









Remember  
to annotate  
as you read.

Notes

# The South Pole

an excerpt from  
*Twenty Thousand Leagues Under the Sea*

by Jules Verne

Twenty Thousand Leagues Under the Sea is a science fiction novel written by Jules Verne. Published in 1870, the book is about an expedition in search of a sea monster that has been spotted by several ships. The novel's narrator, a French marine biologist named Pierre Aronnax, is aboard the ship along with his servant Conseil. Also on board is Canadian harpoonist Ned Land. When the three characters find the "monster," they discover it is actually a submarine whose commander, Captain Nemo, takes them captive. Aboard Nemo's vessel, called the Nautilus, they travel the seven seas, exploring the world's oceans. In the following excerpt, they arrive at the South Pole.



- 1 "Are we at the pole?" I asked the Captain, with a beating heart.
- 2 "I do not know," he replied. "At noon I will take our bearings."
- 3 "But will the sun show himself through this fog?" said I, looking at the leaden sky.
- 4 "However little it shows, it will be enough," replied the Captain.
- 5 About ten miles south a solitary island rose to a height of one hundred and four yards. We made for it, but carefully, for the sea might be strewn with banks. One hour afterwards we had reached it; two hours later we had made the round of it. It measured four or five miles in circumference. A narrow canal separated it from a considerable stretch of land, perhaps a continent, for we could not see its limits.



## Notes

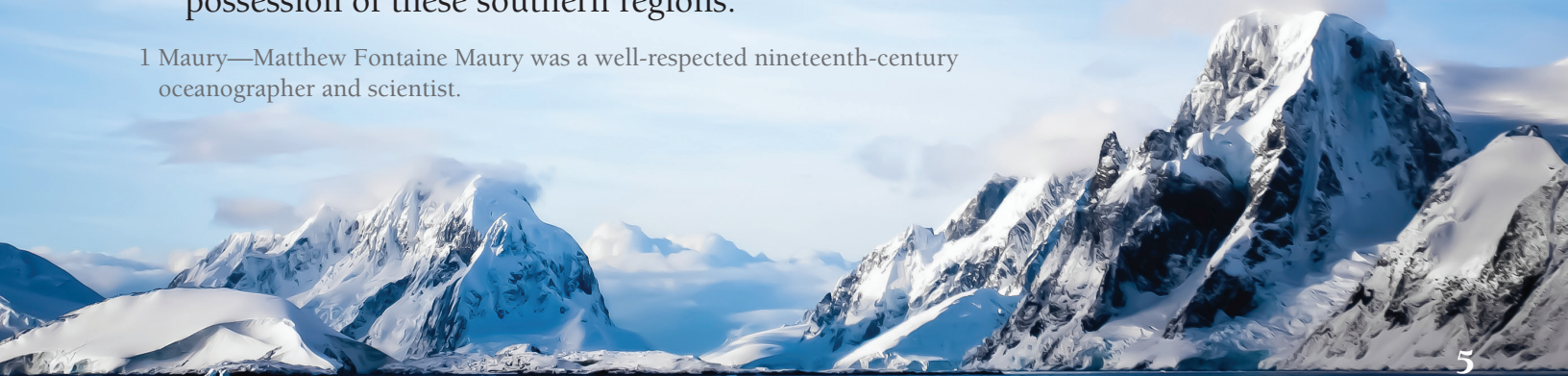
6 The existence of this land seemed to give some color to Maury's<sup>1</sup> theory. The ingenious American has remarked that, between the South Pole and the sixtieth parallel, the sea is covered with floating ice of enormous size, which is never met within the North Atlantic. From this fact he has drawn the conclusion that the Antarctic Circle encloses considerable continents, as icebergs cannot form in open sea, but only on the coasts. According to these calculations, the mass of ice surrounding the southern pole forms a vast cap, the circumference of which must be at least 2,500 miles. But the *Nautilus*, for fear of running aground, had stopped about three cable-lengths from a strand over which reared a superb heap of rocks. The boat was launched; the Captain, two of his men, bearing instruments, Conseil, and myself were in it. It was ten in the morning. I had not seen Ned Land. Doubtless the Canadian did not wish to admit the presence of the South Pole. A few strokes of the oar brought us to the sand, where we ran ashore. Conseil was going to jump on to the land, when I held him back.

7 "Sir," said I to Captain Nemo, "to you belongs the honor of first setting foot on this land."

8 "Yes, sir," said the Captain, "and if I do not hesitate to tread this South Pole, it is because, up to this time, no human being has left a trace there."

9 Saying this, he jumped lightly on to the sand. His heart beat with emotion. He climbed a rock, sloping to a little promontory, and there, with his arms crossed, mute and motionless, and with an eager look, he seemed to take possession of these southern regions.

<sup>1</sup> Maury—Matthew Fontaine Maury was a well-respected nineteenth-century oceanographer and scientist.



Remember  
to annotate  
as you read.

Notes

# Glaciers on the Move

by Kathy Furgang

- 1        Glaciers have created some of the most amazing features of Earth's surface. Made up of fallen snow that over time hardens into ice, glaciers are slow-moving masses that carve out landforms as they go. John Muir, the noted environmentalist and writer, studied glaciers. In his book *Travels in Alaska*, he described his months living in "the ice-world" as follows: "[This] beautiful and terrible network of crevasses, the clustering pinnacles, the thousand streams ringing and gurgling in azure channels cut in the living body of the glacier, the glorious radiance of the sunbeams falling on crystal dale and hill, the rosy glow of the dawn and sunset, the march of the clouds on the mountains, and the mysterious splendor of the auroras when the nights grow long."
- 2        Glaciers have been forming, melting, and moving across Earth's surface for millions of years. For a glacier to form, the amount of snow that falls each year must be more than the amount that melts. When Earth's climate is going through an overall cooling phase, more glaciers form. When the climate goes through an overall warming effect, glaciers melt.

**Most glaciers form in high mountain regions. This glacier is located in Glacier Bay, Alaska.**







Glacier Point at Yosemite National Park, CA, was carved out by glaciers.

Notes

## New Landforms

- 3 Most glaciers move a few centimeters to a few meters each day. The pressure from the weight of ice, along with the force of gravity, changes the shape of the glacier and causes it to flow downhill very slowly. Meltwater<sup>1</sup> at the bottom of the glacier increases its speed, helping it to glide over the landscape. Glacial movement is greatest in summer when the meltwater levels are highest.
- 4 As glaciers move, the flowing ice erodes the land and deposits the material elsewhere. In this process, called erosion and deposition, a glacier picks up and brings along Earth's materials. The sharp, jagged edges of rocks, soil, and debris scrape along the ground, sculpting Earth's surface. New landscapes are created. This process, however, can take millions of years.
- 5 Valleys are one kind of landform that can be created by glaciers. Valleys formed by glaciers are called glaciated valleys. In the United States, Yosemite National Park is one of the most beautiful examples. Ansel Adams, a nature photographer, said this about the park: "Yosemite Valley, to me, is always a sunrise, a glitter of green and golden wonder in a vast edifice of stone and space."

<sup>1</sup> meltwater—water made from melting ice and snow

## Glaciers and the Great Lakes

- 6 In the Cherokee's "Ice Man" myth, the Great Lakes region went through a phase of fire, and then ice, leading to the formation of a lake. Like many myths and pourquoi tales, this story was told by some early cultures to help explain natural phenomena. In reality, the Cherokee's got some of the scientific concept right. Volcanic eruptions first changed the landscape of the area, forming mountains. Then around 100,000 years ago, the most recent ice age began. Advancing glaciers eventually covered the area.
- 7 Over time the climate began to warm and the glaciers retreated, or began to shrink. These thick, heavy, and powerful glaciers gouged deep holes in Earth as they slowly moved, creating the lake basins. Around 20,000 years ago the climate warmed, causing meltwater from the glaciers to fill the lake basins. The glaciers kept melting and so water kept filling the basins until about 4,000 years ago, when the lakes reached their current form. Glacial features, such as deposits of silt, clay, and sand, are still visible today on the Great Lakes basin in North America.





## Glacial Ages

- 8 An ice age on Earth is also called a glacial period. Earth's last glacial period ended more than 11,000 years ago. As those glaciers melted and pushed the land, they created lakes, valleys, and mountains, among other landforms. According to the Environmental Protection Agency, Earth will experience another glacial advance in the next 10,000 to 20,000 years.
- 9 Today, glaciers cover more than 15 million square kilometers (6 million square miles) of Earth's land. The largest glacier is an ice sheet that covers the eastern part of Antarctica. In some places, it is more than 4,200 meters (13,800 feet) thick.

### The Future of Glaciers?

**There are still many glaciers on Earth, but because of global warming they are shrinking. In 1910, when the U.S. government established Glacier National Park in Montana, there were approximately 150 glaciers. Today only 25 glaciers larger than 25 acres still exist.**



**photographic documentation of changes in Grinnell Glacier in Glacier National Park, MT, 1938–2009**

Remember  
to annotate  
as you read.

## Notes

# The Origin of Earth

- 1 Many moons ago, long before there were any people, there was water everywhere. In that ancient time, Earth was unseen and undiscovered, and only birds existed. One day, the birds held an important council meeting to determine whether it was best to continue having only water or to create land too. "If we have land, perhaps we could secure more food," suggested several birds. However, others preferred to continue with the way things were because dealing with change and new ways might be difficult. Since Eagle was their wise and trustworthy chief, the birds asked him to decide what they should do.
- 2 After days of careful deliberation, Eagle announced his decision. "We shall be better off if we have both water and land in our universe," he proclaimed. Then he appointed Dove to fly away in search of land, which she promptly did. However, after several days of flying hither and yon, she returned with the disappointing news that she couldn't find land anywhere. So Eagle next asked Crawfish to search for land beneath the water.
- 3 Crawfish went underwater, searching and exploring for many days. Finally, deep down in the ocean, she discovered land and scooped some of it up in her claws. When she surfaced with her claws full, she handed the precious balls of land to Eagle, who then created a small island out of them. Soon all the birds flew to the new island that Eagle had formed, and they happily agreed that it was, indeed, a good place to live.
- 4 Over time, the island grew larger and larger, and the water descended lower and lower. Soon more islands appeared, and gradually, all the islands grew together to form what is now our magnificent Earth.



# BuildReflectWrite

## Build Knowledge

Contrast the “theory” about glaciers presented by Verne’s narrator in “The South Pole” to information presented in “Glaciers on the Move.” In what ways does the theory in the fictional account differ from the explanation presented in the nonfiction reading? Summarize your ideas below.

“The South Pole”	“Glaciers on the Move”
<b>Explanation:</b>	<b>Explanation:</b>
<b>Summary:</b>	

## Reflect

### How does Earth itself inspire human endeavors?

Based on this week’s texts, write down new ideas and questions you have about the essential question.

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## Research and Writing

### Narrative

Research an unexplored or extreme place on Earth. Write a scene from a science fiction story in which your characters are exploring the location.

#### CHOOSE YOUR TOPIC

This week, conduct a pre-search to identify an unexplored or extreme place on Earth you would like to research. Construct three or more guiding questions that will help you focus your research on the information you will need to write your story.



Remember  
to annotate  
as you read.

Notes

# We Continue Our Descent

an excerpt from  
*Journey to the Center of the Earth*

by Jules Verne

Jules Verne's classic science fiction novel *Journey to the Center of the Earth* (1864) tells of a daring expedition by a group of scientists who hope to discover how Earth was formed and what is in its core. The expedition, led by Professor Hardwigg, includes his nephew, Harry, a budding scientist, and their guide, Hans.



Jules Verne

Verne, acknowledged as the father of modern science fiction, weaves current scientific information from the time into the story, such as Humphry Davy's theory of volcanic energy. Davy, famous for discovering and separating chemical elements, believed that Earth's core and volcanoes happened as a result of chemical changes. Some of his contemporaries also believed, erroneously, that volcanoes and Earth's core were not extremely hot.

Verne also brings in science tools that, for the time, were on the cutting edge of technology. The Ruhmkorff coil apparatus, an electric lighting device, was a precursor to the modern flashlight.

Whether invoking science theories or facts, or inventing science to suit his fiction, Verne knew it was important to learn about Earth's core to better understand how Earth was formed.

In this excerpt from Chapter 15, the men in the expedition have gone to Iceland and are now descending through a volcano cone on their journey to the center of Earth.



## Notes

1 “Now, Harry,” cried  
the Professor, in an  
enthusiastic tone of voice,  
“we are truly about to  
take our first step into  
the interior of the Earth,  
never before visited  
by man since the first  
creation of the world. You  
may consider, therefore,  
that at this precise  
moment our travels really  
commence.”

2 As my uncle made  
this remark, he took in one hand the Ruhmkorff coil  
apparatus, which hung round his neck, and with the  
other he put the electric current into communication  
with the worm of the lantern and a bright light at once  
illumined that dark and gloomy tunnel!

3 The effect was magical!

4 Hans, who carried the  
second apparatus, had it also put  
into operation. This ingenious  
application of electricity to practical  
purposes enabled us to move along  
by the light of an artificial day, amid even the flow of  
the most inflammable and combustible gases.



Ruhmkorff coil

5 “Forward!” cried my uncle. Each took up his  
burden. Hans went first, my uncle followed, and I  
going third, we entered the somber gallery!

6 Just as we were about to engulf ourselves in this  
dismal passage, I lifted up my head, and through the  
tubelike shaft saw that Iceland sky I was never to see  
again!

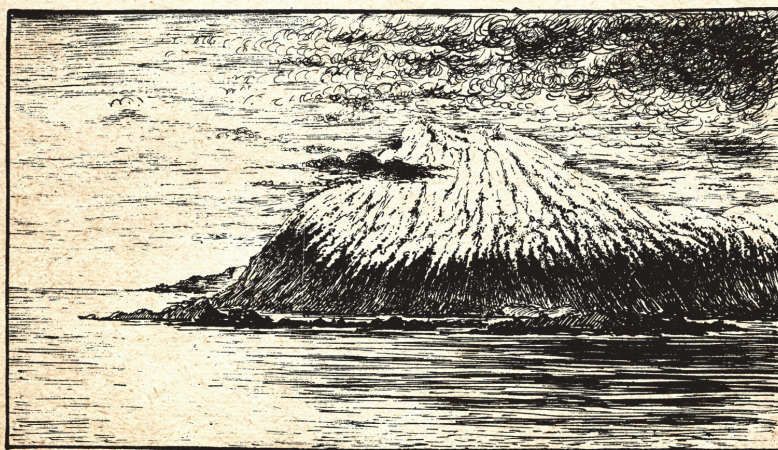


7 Was it the last I should ever see of any sky?

8 The stream of lava flowing from the bowels of the earth in the year 1219<sup>1</sup> had forced itself a passage through the tunnel and it lined the whole of the inside with its thick and brilliant coating. The electric light added very greatly to the brilliancy of the effect.

9 The great difficulty of our journey now began. How were we to prevent ourselves from slipping down the steeply inclined plane? Happily some cracks, abrasures of the soil, and other irregularities served the place of steps and we descended slowly, thus allowing our heavy luggage to slip on before, at the end of a long cord.

10 But that which served as steps under our feet became in other places stalactites. The lava, very porous in certain places, took the form of little round blisters. Crystals of opaque quartz, adorned with limpid drops of natural glass suspended to the roof like lusters, seemed to take fire as we passed beneath them. One would have fancied that the genii of romance were illuminating their underground palaces to receive the sons of men.



<sup>1</sup> the year 1219—Verne refers to the date the Snæfells volcano (artist's interpretation above) in Iceland last erupted. The date, however, is about 1,000 years too recent. What's more, Verne's "science" is off; the expedition could not have entered from that vantage point, as ice covers the volcano.



## Notes

11 “Magnificent, glorious!” I cried in a moment of involuntary enthusiasm, “What a spectacle, Uncle! Do you not admire these variegated shades of lava, which run through a whole series of colors, from reddish brown to pale yellow—by the most insensible degrees? And these crystals, they appear like luminous globes.”

12 “You are beginning to see the charms of travel, Master Harry,” cried my uncle. “Wait a bit, until we advance farther. What we have as yet discovered is nothing—onwards, my boy, onwards!”



wood engraving after a drawing by Édouard Riou from a 19th-century edition of *Journey to the Center of the Earth*



- 13 It would have been a far more correct and appropriate expression had he said, "let us slide," for we were going down an inclined plane with perfect ease. The compass indicated that we were moving in a southeasterly direction. The flow of lava had never turned to the right or the left. It had the inflexibility of a straight line.
- 14 Nevertheless, to my surprise, we found no perceptible increase in heat. This proved the theories of Humphry Davy<sup>2</sup> to be founded on truth, and more than once I found myself examining the thermometer in silent astonishment.
- 15 Two hours after our departure it only marked fifty-four degrees Fahrenheit. I had every reason to believe from this that our descent was far more horizontal than vertical. As for discovering the exact depth to which we had attained, nothing could be easier. The Professor as he advanced measured the angles of deviation and inclination, but he kept the result of his observations to himself.
- 16 About eight o'clock in the evening, my uncle gave the signal for halting. Hans seated himself on the ground. The lamps were hung to fissures in the lava rock. We were now in a large cavern where air was not wanting. On the contrary, it abounded. What could be the cause of this, to what atmospheric agitation could be ascribed this draft? But this was a question which I did not care to discuss just then, as fatigue and hunger made me incapable of reasoning. An unceasing march of seven hours had not been kept up without great exhaustion and I was really and truly worn out, and delighted enough I was to hear the word *Halt*.

<sup>2</sup> Humphry Davy (1778–1829)—theorized that chemical changes would not drastically change the temperature of Earth's core. He was incorrect; the core's temperature is estimated at about 6,000°C (10,800°F).



## Notes

17 Hans laid out some provisions on a lump of lava, and we each supped with keen relish. One thing, however, caused us great uneasiness—our water reserve was already half exhausted. My uncle had full confidence in finding subterranean resources, but hitherto we had completely failed in so doing and I could not help calling my uncle's attention to the circumstance. "And you are surprised at this total absence of springs?" he said.





18 “Doubtless—I am very uneasy on the point and we have certainly not enough water to last us five days.”

19 “Be quite easy on that matter,” continued my uncle. “I answer for it we shall find plenty of water—in fact, far more than we shall want.”

20 “But when?”

21 “When we once get through this crust of lava. How can you expect springs to force their way through these solid stone walls?”

22 “But what is there to prove that this concrete mass of lava does not extend to the center of the earth? I don’t think we have as yet done much in a vertical way.”

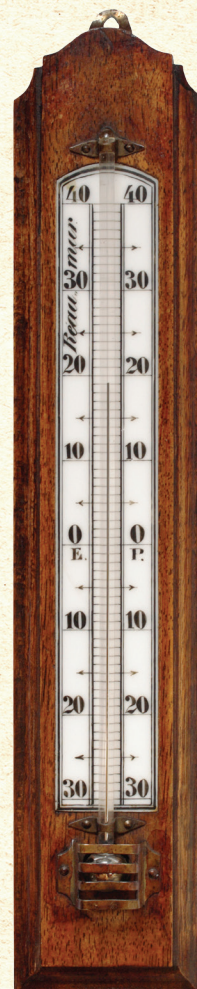
23 “What puts that into your head, my boy?” asked my uncle mildly.

24 “Well, it appears to me that if we had descended very far below the level of the sea—we should find it rather hotter than we have.”

25 “According to your system,” said my uncle, “but what does the thermometer say?”

26 “Scarcely fifteen degrees by Réaumur,<sup>3</sup> which is only an increase of nine since our departure.”

27 “Well, and what conclusion does that bring you to?” inquired the Professor.



Réaumur thermometer

<sup>3</sup> Réaumur—a scale in which the freezing temperature of water is set at 0° and the boiling point in normal atmosphere is set at 80°. It was a French system popular until the late 1800s. Verne is said to have used it to satirize scientists and their many formulas that came in and out of popularity.



## Notes

28 “The deduction I draw from this is very simple. According to the most exact observations, the augmentation of the temperature of the interior of the earth is one degree for every hundred feet. But certain local causes may considerably modify this figure. The difference evidently depends on the conductibility of certain rocks. In the neighborhood of an extinct volcano, it has been remarked that the elevation of temperature was only one degree in every five-and-twenty feet. Let us, then, go upon this calculation—which is the most favorable—and calculate.”

29 “Calculate away, my boy.”

30 “Nothing easier,” said I, pulling out my notebook and pencil. “Nine times one hundred and twenty-five feet make a depth of eleven hundred and twenty-five feet.”

31 “Archimedes<sup>4</sup> could not have spoken more geometrically.”

32 “Well?”

33 “Well, according to my observations, we are at least ten thousand feet below the level of the sea.”

34 “Can it be possible?”

35 “Either my calculation is correct, or there is no truth in figures.”

36 The calculations of the Professor were perfectly correct. We were already six thousand feet deeper down in the bowels of the earth than anyone had ever been before. The lowest known depth to which man had hitherto penetrated was in the mines of Kitzbühel, in the Tirol, and those of Württemberg.<sup>5</sup>

37 The temperature, which should have been eighty-one, was in this place only fifteen. This was a matter for serious consideration.

<sup>4</sup> Archimedes—an ancient Greek mathematician known for his mathematical formulas

<sup>5</sup> Württemberg—along with other places mentioned, a historically ethnic German area



Remember  
to annotate  
as you read.

## Notes

## Jules Verne: Master of Science Fiction

- 1 Jules Verne (1828–1905) grew up in the seaport city of Nantes, France, in the 1830s. As a boy, he enjoyed watching ships travel to and from the port. Perhaps that's what sparked his imagination to write about fascinating voyages.
- 2 Verne's father, a practical man, wanted his son to be a lawyer, so Verne went on to study law but gave it up to write stories. When he couldn't earn a living as a writer, Verne became a stockbroker but continued writing on the side. Being a stockbroker gave him enough financial stability to get married in 1857 and start a family.
- 3 However, Verne never gave up writing, and in 1862, his persistence finally paid off. He met the publisher Pierre-Jules Hetzel, who agreed to publish Verne's first novel, *Five Weeks in a Balloon*. It was a unique story of three explorers who traveled to Africa in a hot-air balloon. It blended science with adventure so realistically that many readers wondered whether it was fact or fiction. It became an international best seller!
- 4 Verne's next book, *The Adventures of Captain Hatteras*, described a voyage to the Arctic. Then he wrote *Journey to the Center of the Earth*, which many believe is his finest work. In both novels, he included scientific theories about Earth's evolution. His next books, *From the Earth to the Moon* and *20,000 Leagues Under the Sea*, were written long before space and submarine travel became realities. He followed up with the lighthearted novel *Around the World in Eighty Days*.
- 5 Jules Verne had a unique style that combined science and adventure to make his stories seem real. He has inspired the imaginations of millions of readers, including famous scientists and inventors. His timeless novels will, no doubt, continue to inspire future generations.



# BuildReflectWrite

## Build Knowledge

After reading “We Continue Our Descent,” identify what you think are the three most important events in the story; cite details and examples to support your point of view. Then hypothesize about what happens after the excerpt ends (para. 37).

### Events and Details

1.

2.

3.

**Hypothesis:**

## Reflect

**How does Earth itself inspire human endeavors?**

Based on this week’s texts, write down new ideas and questions you have about the essential question.

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## Research and Writing

**Narrative**

Research an unexplored or extreme place on Earth. Write a scene from a science fiction story in which your characters are exploring the location.

**CONDUCT RESEARCH**

Use your guiding questions to conduct research this week. Gather information from at least three sources, including both print and online sources. Use your sources to plan your story.



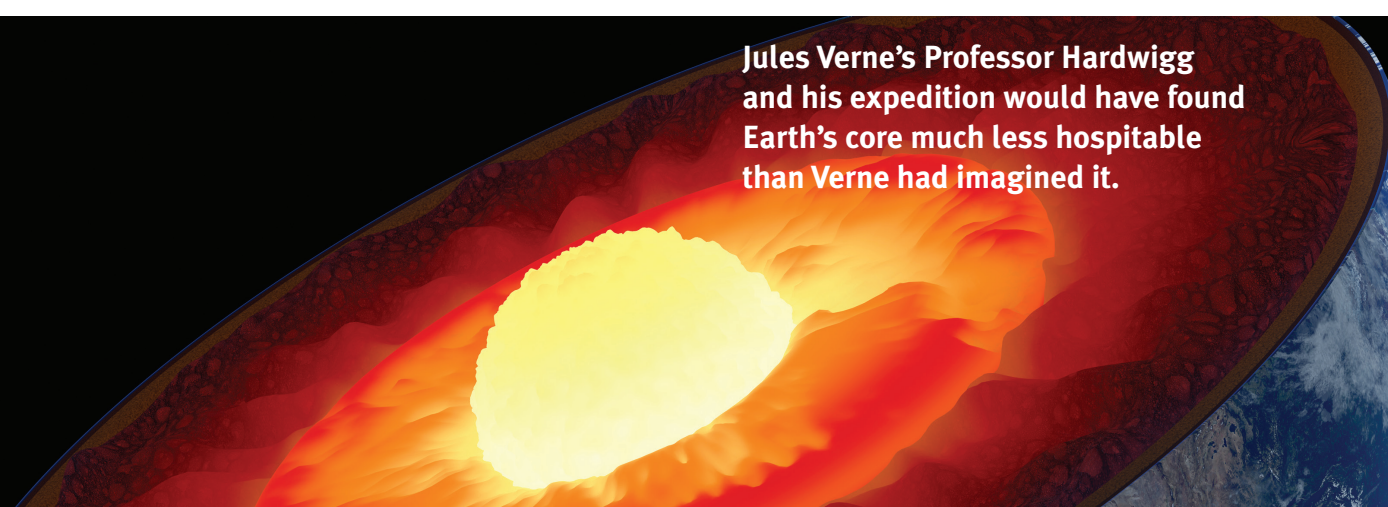
Remember  
to annotate  
as you read.

## Notes

# Studying Earth's Core

by Tom Johnson

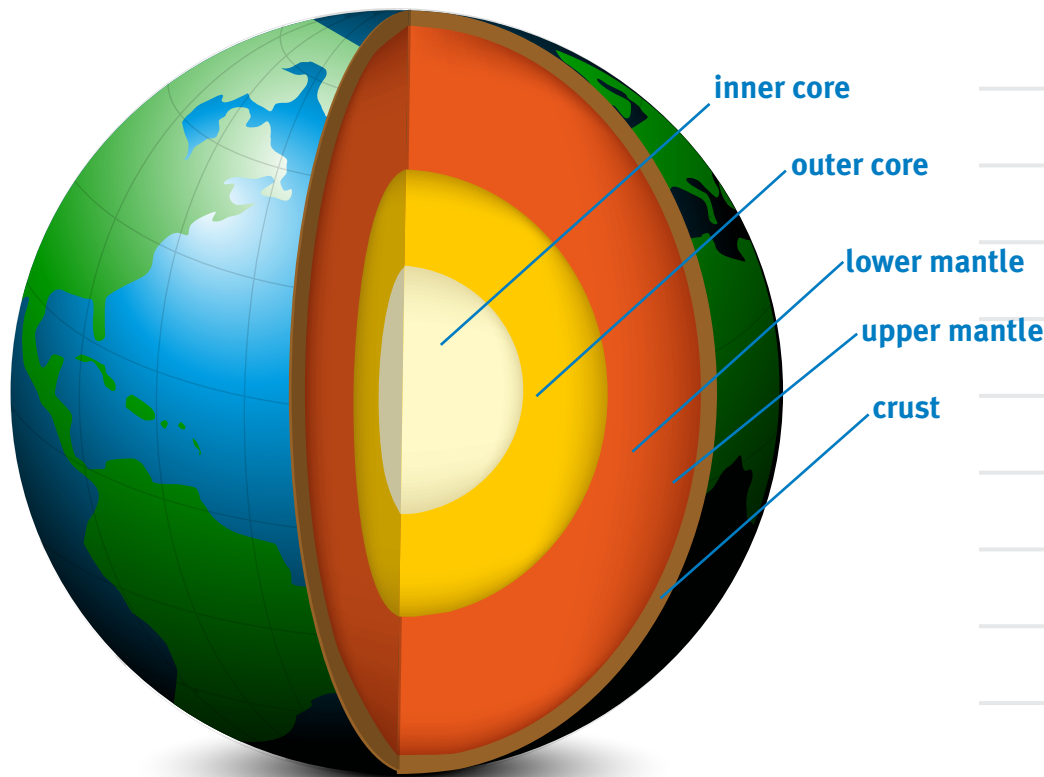
- 1 The only life on Earth—that we know of—exists on its surface, on the land and in the water. Scientists have studied Earth's surface for thousands of years. But what do we know about what lies below the surface? For those same thousands of years, people have told tales about what might be living deep inside Earth. Or they invented stories to explain some of the natural phenomena they observed. For example, in Hawaiian folktales, the angry goddess Pele caused earthquakes and volcanoes.
- 2 What's below Earth's surface has piqued the curiosity of scientists as well. Sir Edmond Halley (1656–1742), who discovered Halley's Comet, postulated in 1692 that Earth might be a hollow ball with three smaller spheres around it. He speculated that these spheres might even be inhabited. Other scientists through the 1800s also believed in this “hollow Earth” theory. The science fiction author Jules Verne (1828–1905) took this scientific theory and imagined a hollow Earth with strange creatures. In Verne's *Journey to the Center of the Earth*, a scientific expedition led by Professor Hardwigg descends into a volcano, then through many layers of rock.



Jules Verne's Professor Hardwigg and his expedition would have found Earth's core much less hospitable than Verne had imagined it.



## Notes



- 3 Within each layer, Verne's expedition finds ancient plants, mushrooms, and other kinds of fossils that "tell" Earth's story. In the 150 years since the book's publication, geological studies and other scientific evidence have shown that Earth's core is quite different from the one that Verne imagined. Studies also show that Earth is not hollow or filled with spheres and different life-forms.

## Earth's Layers

- 4 After years of study, scientists have been able to "reveal" the interior of Earth. As earlier scientists theorized, the interior of Earth is a layered structure. It has an inner core composed of solid metal and an outer core made up of hot molten lava. The outer core is surrounded by a mantle, which has upper and lower levels. The upper level, or lithosphere, is cold, dense rock. The lower mantle is composed of partly molten rock. Earth's crust, or surface, includes landforms and bodies of water. It is formed by plates of rock.



- 5 In the seventeenth and eighteenth centuries, Sir Isaac Newton (1642–1727) wrote about gravity, and forces and motion. From his studies of planets and the force of gravity, he calculated that the average density of Earth is twice that of the rocks on the surface. He then concluded that Earth’s interior must be made up of much denser material.
- 6 Scientists today know they can’t enter Earth through a dormant volcano and hike to the center of the planet. The inner core layer begins about 6,400 kilometers (4,000 miles) beneath the crust. It is almost 1,300 kilometers (800 miles) thick. Arianna Gleason, a geoscientist who studies Earth’s core at Stanford University in California, explained, “The Earth’s inner core is the most remote part of our planet, and so there is a lot we don’t know about it because we can’t go down and collect samples.” Still, the fact that there is no way to reach the core has not stopped scientists from trying to learn what they can about it.

### **What Rocks Can Tell Us**

- 7 Scientists, thus far, have only been able to study materials from 11 kilometers (7 miles) below Earth’s surface. They use direct observations about rocks and meteorites, and evidence from earthquakes. They also use indirect methods, such as studying seismic waves, which are energy waves or vibrations that travel through Earth as the result of an earthquake, a subterranean explosion, or volcanic activity.
- 8 By studying surface rocks today, scientists have further learned about the composition and density of the mantle. For example, one rock found on the surface of Earth is called peridotite. Scientists study this rock type because they believe it is found in Earth’s mantle and therefore gives clues about the pressure in that layer.



## Notes

- 9 Scientists reached this conclusion based on analysis of a diamond-bearing volcanic rock called kimberlite, which contains peridotite. High pressure, such as that which occurs 150 kilometers (93 miles) inside Earth, is needed for a diamond to form. So scientists think that the peridotite fragments in the kimberlite are portions of the mantle from the same depth. The rocks made it to the surface from a volcanic eruption. Geologists, scientists who study rocks, use such samples to draw conclusions about the mantle.



garnet peridotite

### Volcanoes Tell a Story

Jules Verne knew that volcanoes were connected to what lay beneath Earth's surface, and that's why his fictional expedition used a volcano as an entrance to Earth's core. The photo here shows the volcano area in Iceland that Verne used as his setting in *Journey to the Center of the Earth*. Volcanoes may not provide an entrance to Earth's core, but they do offer information about the makeup of the core.



## Seismic Waves

10 In their journey, Jules Verne's characters encounter oceans and waves in the center of Earth. In reality, waves do exist inside Earth, but they are not the types of waves Verne envisioned. They are waves of energy. Seismologists (scientists who study seismic<sup>1</sup> waves) glean information about Earth's core by measuring how different types of waves travel through Earth's interior. The speed of the waves depends on the density of the materials that the waves are passing through, so measuring the waves and their speed provides data about inner Earth's various layers.

11 Danish seismologist Dr. Inge Lehmann (1888–1993) is credited with discovering Earth's inner core. Like Verne's Professor Hardwigg, Dr. Lehmann studied the center of Earth, albeit from the surface. In 1929, a major earthquake occurred near New Zealand. Dr. Lehmann analyzed the earthquake's waves and was puzzled by what she found. Some waves, which normally wouldn't pass through the core, were recorded at seismic stations. How could this be?



**Dr. Inge Lehmann**

12 Lehmann proposed that these waves had traveled into the core and then bounced off some kind of boundary. She theorized that Earth's center consisted of two parts: a solid inner core surrounded by a liquid outer core, separated by what is now called the Lehmann Discontinuity. Her theory was verified in 1970 by more advanced seismographs, which detected waves deflecting off this solid core.

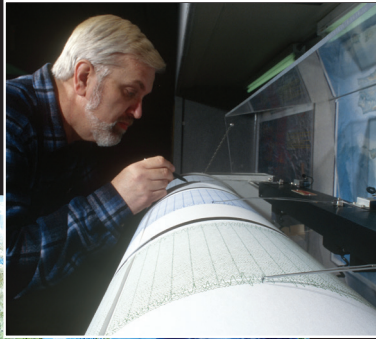
<sup>1</sup> seismic—from the Greek word *seismos*, meaning “vibrations”



## Notes

**Seismograph**

A seismograph detects and records earthquakes. The study of seismic waves has helped reveal the structure of Earth's interior.

**The Heat Is On**

- 13 One “fact” Verne got wrong in his book is the temperature of the center of Earth. For years, miners have known that temperature increases the deeper they go into Earth. The deepest gold mine is in South Africa. At 3.9 kilometers (2.4 miles) deep, the Tautoua mine gets so hot that ice has to be pumped down to cool the tunnels. A reporter doing a story on the mine said, “It is like crawling into a pizza oven.”
- 14 Verne was following a popular theory at the time. Humphry Davy’s theory of volcanic energy proposed that volcanoes resulted from chemical changes, not from the buildup of pressure from heat and gases. Scientists who followed Davy’s theory believed the core was not hot. Verne’s interpretation of this “science” allowed for an imaginative adventure. In reality, his expedition would have burned up long before it got to the core.
- 15 New information from a study published in *Science* magazine in 2013 indicates that the Earth’s core is around 6,000° Celsius (10,832° Fahrenheit). That is 1,000°C (1,832°F) hotter than had previously been believed, and about as hot as the surface of the sun.



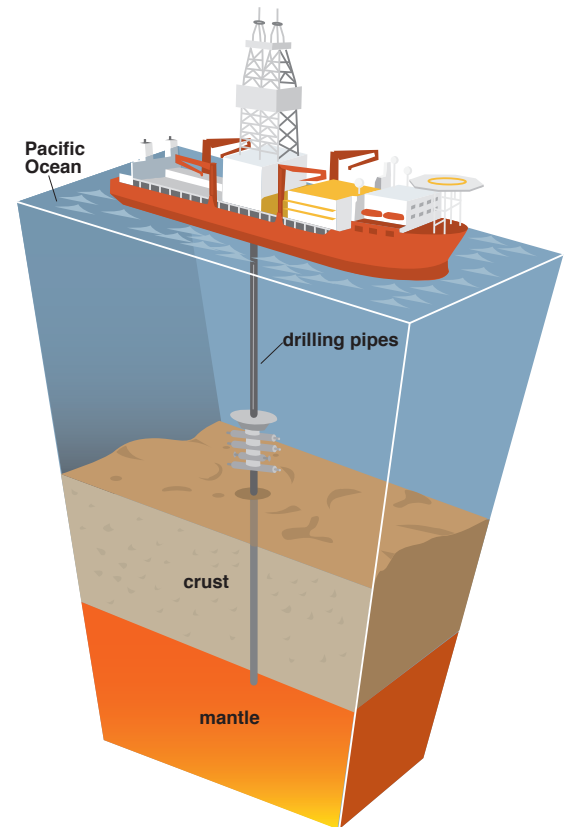
## The 21st-Century Journey Continues

16 A physical journey to the center of Earth will most likely never be possible for humans. However, scientists are working to take a different kind of journey to the center of Earth. A team of international scientists is planning to drill into Earth's mantle.

17 According to a 2012 report on CNN, the mission is to drill 6 kilometers (3.7 miles) beneath the floor of the Pacific Ocean. This operation will cost one billion dollars or more. Geologists are hoping that, if successful, this operation will

answer questions about Earth's beginnings and how, over time, Earth has changed. If they are able to answer these questions, then they will also be able to make some accurate predictions about Earth's future.

18 One of the leaders, Damon Teagle, calls the mission "the most challenging endeavor in the history of Earth science." He explains that "[the mantle] is the engine that drives how our planet works and why we have earthquakes and volcanoes and continents. We have the textbook cartoons, but detailed knowledge is lacking."



**A group of scientists plans to drill a 30-centimeter (11 3/16-inch) hole in Earth's mantle from a site in the Pacific Ocean. They will use 10-kilometer (6.2-mile) long drill pipes to drill 6 kilometers (almost 4 miles) into the seafloor and retrieve samples for study.**



## Notes

19 Unlike Verne's trip to the center of Earth, which lasted about three months, this mission will take years to complete. According to Teagle, the team hopes to reach Earth's mantle by the early 2020s.

20 As an author of science fiction, Verne used scientific theories and ideas that matched his story concept and fueled his imagination. What may have been based on facts became fodder for speculative fiction. His characters, however, as good scientists, used the scientific method to try to find answers to their questions. They posed hypotheses, conducted experiments, and then drew conclusions based on facts and the results of their experiments or analyses.

21 Today, scientists are following in Professor Hardwigg's footsteps, if not his exact path, and continue to study what's below Earth's surface. As with Verne's expedition, these scientists make new and exciting discoveries too. And maybe their discoveries will lead to new science fiction adventures.

**Scientists continue to study volcanoes to learn more about Earth's center.**





Remember  
to annotate  
as you read.

## Notes

# Drilling Into Earth's Mantle

- 1 Between Earth's surface and its core lies Earth's invisible mantle, a thick layer of very hard rock. Although the mantle makes up most of Earth's mass, we know very little about it. However, that will soon change. A team of international scientists is going to drill into the mantle for the first time. Scientists believe that learning more about the makeup of the mantle will help them understand the origins of Earth.
- 2 This will be a huge engineering project, surpassing most others in difficulty. To reach the mantle, the researchers will use a special deep-sea drilling vessel from Japan. Researchers have chosen three locations in the Pacific Ocean as possible drilling sites. The team will submerge long drill pipes to drill the ocean floor and reach the mantle. The drill bits to be used have a limited lifespan. They last for only about 60-hour intervals before they have to be replaced. Since this is the best technology that is currently available, scientists envision it will take a long time to reach the mantle. They calculate that they will be able to extract the first samples sometime in the 2020s.
- 3 Since the mission is so complex, its cost is estimated to be more than one billion dollars. However, those involved believe that the substantial knowledge to be gained will be well worth the cost. Besides providing information about Earth's origins and history, samples from the mantle will also help scientists understand the forces that cause destructive earthquakes, tsunamis, and volcanic eruptions.



# BuildReflectWrite

## Build Knowledge

Determine three main ideas in the reading selection “Studying Earth’s Core.” What supporting details does the writer use to develop these ideas? Record your responses in the chart below.

Main Ideas	Supporting Details
1.	
2.	
3.	

## Reflect

**How does Earth itself inspire human endeavors?**

Based on this week’s texts, write down new ideas and questions you have about the essential question.

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## Research and Writing

### Narrative

Research an unexplored or extreme place on Earth. Write a scene from a science fiction story in which your characters are exploring the location.

WRITE YOUR FICTION STORY

Use your research results to draft, revise, and edit your scene from a science fiction story. Share your story with your peers.



# Support for Collaborative Conversation

## Discussion Prompts

### Express ideas or opinions . . .

When I read \_\_\_\_\_, it made me think that \_\_\_\_\_.

Based on the information in \_\_\_\_\_, my [opinion/idea] is \_\_\_\_\_.

As I [listened to/read/watched] \_\_\_\_\_, it occurred to me that \_\_\_\_\_.

It was important that \_\_\_\_\_.

### Gain the floor . . .

I would like to add a comment. \_\_\_\_\_.

Excuse me for interrupting, but \_\_\_\_\_.

That made me think of \_\_\_\_\_.

### Build on a peer's idea or opinion . . .

That's an interesting point. It makes me think \_\_\_\_\_.

If \_\_\_\_\_, then maybe \_\_\_\_\_.

[Name] said \_\_\_\_\_. That could mean that \_\_\_\_\_.

### Express agreement with a peer's idea . . .

I agree that \_\_\_\_\_ because \_\_\_\_\_.

I also feel that \_\_\_\_\_ because \_\_\_\_\_.

[Name] made the comment that \_\_\_\_\_, and I think that is important because \_\_\_\_\_.

### Respectfully express disagreement . . .

I understand your point of view that \_\_\_\_\_, but in my opinion \_\_\_\_\_ because \_\_\_\_\_.

That is an interesting idea, but did you consider the fact that \_\_\_\_\_?

I do not agree that \_\_\_\_\_. I think that \_\_\_\_\_ because \_\_\_\_\_.

### Ask a clarifying question . . .

You said \_\_\_\_\_. Could you explain what you mean by that?

I don't understand how your evidence supports that inference. Can you say more?

I'm not sure I understand. Are you saying that \_\_\_\_\_?

### Clarify for others . . .

When I said \_\_\_\_\_, what I meant was that \_\_\_\_\_.

I reached my conclusion because \_\_\_\_\_.

## Group Roles

### Discussion director:

Your role is to guide the group's discussion. Ask your peers to explain and support their responses.

### Notetaker:

Your job is to record the group's ideas and important points of discussion.

### Summarizer:

You will write a short summary of the group's comments and conclusions. Check with the group members that it accurately reflects their ideas.

### Connector:

In this role, you will look for connections between the group's discussion and ideas you've talked about in class or events that have happened in the real world.

### Presenter:

Your role is to provide an overview of the group's discussion to the class.

### Timekeeper:

Your job is to track the time and keep your peers on task.



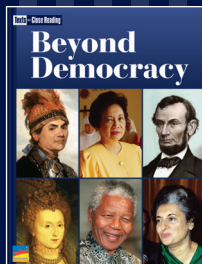
# Making Meaning with Words

Word	My Definition	My Sentence
<b>accurate</b> (p. 28)		
<b>approximately</b> (p. 9)		
<b>channels</b> (p. 6)		
<b>circumference</b> (p. 5)		
<b>glean</b> (p. 26)		
<b>interpretation</b> (p. 27)		
<b>involuntary</b> (p. 15)		
<b>irregularities</b> (p. 14)		
<b>modify</b> (p. 19)		
<b>perceptible</b> (p. 16)		

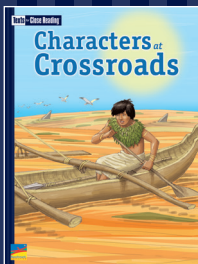


# Build Knowledge Across 10 Topic Strands

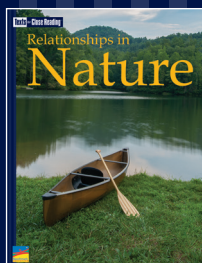
## Government and Citizenship



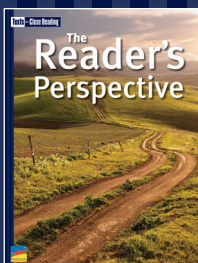
## Character



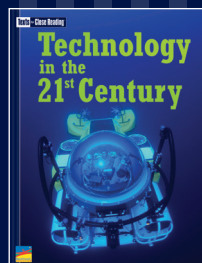
## Life Science



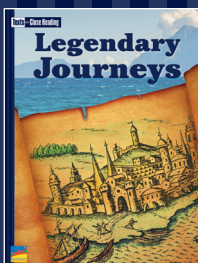
## Point of View



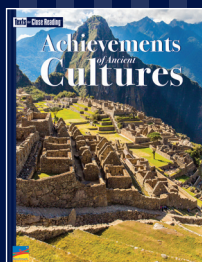
## Technology and Society



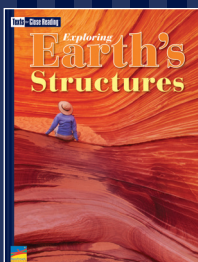
## Theme



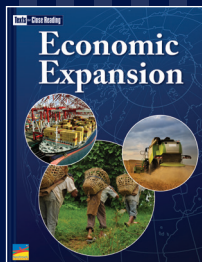
## History and Culture



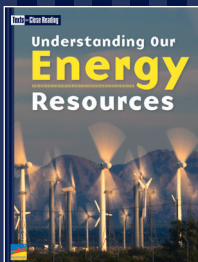
## Earth Science



## Economics



## Physical Science



Grade 6 • Unit 8

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