# Earth's Changing Surface
# Lesson 2a: Volcanoes and Earth's Plates

| | | |
|---|---|---|
| **Grade 4** | **Length of lesson:** 40 minutes | **Placement of lesson in unit:** 2a of 7 two-part lessons on Earth's changing surface |
| **Unit central questions:** Why isn't all of Earth's surface flat? What causes the surface to look different in different places? | | **Lesson focus question:** What happens to Earth's surface that causes mountains to form? |
| **Main learning goal:** Earth's thin outermost layer (crust) is made up of tectonic plates. Volcanic activity is one mechanism that builds up Earth's surface in some places over time. | | |
| **Science content storyline:** Volcanic eruptions are one way mountains form. In some places on Earth, mountains are built as magma erupts from a volcano and then cools into rock. But are other processes involved in mountain building?<br>The outermost surface of Earth is a very thin layer of cold, rigid rock made up of interlocking crustal plates, like puzzle pieces that fit together. These crustal plates are called *tectonic plates*. Do tectonic plates contribute to mountain building? How would that happen? | | |
| **Ideal student response to the focus question:** One way mountains form is when volcanoes erupt and lava flows onto the ground and then cools into hard rock. After a volcano erupts many times, the cooling lava builds up the land. The interlocking plates of Earth's crust are called *tectonic plates*. These plates might also have something to do with mountain building, but we need more information. | | |

**Preparation**

| | |
|---|---|
| **Materials Needed**<br>• Science notebooks<br>• Chart paper and markers<br>• Ways Earth's Surface Might Change over Time (chart of student ideas from lesson 1b)<br>• 2 hard-boiled eggs (1 for demo and 1 for backup)<br>• **Optional:** soccer ball (alternative model of tectonic plates) | **Ahead of Time**<br>• Review Earth's Changing Surface Content Background Document: sections 4–6.<br>• View additional diagrams of Earth's composition at http://en.wikipedia.org/wiki/File:Earth-crust-cutaway-english.svg.<br>• **Note for eggshell demo:** Boil and crack the extra egg in advance and keep it on hand for the demo in case the other egg gets damaged or the sections don't fit together. |

**Lesson 2a General Outline**

| Time | Phase of Lesson | How the Science Content Storyline Develops |
|---|---|---|
| 5 min | **Link to previous lesson:** The class reviews a list of student ideas from the previous lesson about how Earth's surface might change over time. | • The landforms on Earth's surface aren't the same everywhere. |
| 1 min | **Lesson focus question:** The teacher introduces the focus question, *What happens to Earth's surface that causes mountains to form?* | |
| 1 min | **Setup for activity 1:** The teacher introduces the first activity in which students will investigate volcanoes and consider whether they're involved in mountain building. | |
| 8 min | **Activity 1:** Students look at pictures of volcanic eruptions and discuss the resulting changes on Earth's surface. | • Volcanic eruptions change Earth's surface. These eruptions cause the land to build up over time and form mountains. |
| 5 min | **Follow-up to activity 1:** The teacher summarizes key ideas about volcanic activity and mountain building. | • Volcanic eruptions are one way mountains form over time. As magma erupts, lava flows across the landscape and then cools into rock. Over time, these eruptions build up the land and form mountains. |
| 5 min | **Setup for activity 2:** The teacher reviews the focus question and elicits student ideas about how Earth and a hard-boiled egg are alike and different. | • Scientists often use models to learn about real objects. A hard-boiled egg can serve as a model of Earth. Even though we can't see inside Earth, a hard-boiled egg can help us understand Earth's crust. |
| 5 min | **Activity 2:** The teacher uses a cracked eggshell to demonstrate that Earth's crust is very thin and is divided into interlocking plates. | • The outermost surface of Earth is a very thin layer of cold, rigid rock composed of a number of separate but interlocking crustal plates. |
| 3 min | **Follow-up to activity 2:** Students summarize two ways Earth's crust and eggshells are alike. | |
| 6 min | **Synthesize/summarize today's lesson:** Students discuss how today's activities relate to the lesson focus question. | • Volcanic activity is one way mountains form. Other processes may also be involved in mountain building. The thin crust of Earth is divided into sections or plates that fit together like puzzle pieces. These crustal plates, called *tectonic plates*, may cause mountains to form, but we aren't sure how. |
| 1 min | **Link to next lesson:** The teacher links key science ideas to the next lesson. | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| 5 min | **Link to Previous Lesson**<br><br>**Synopsis:** The class reviews a list of student ideas from the previous lesson about how Earth's surface might change over time.<br><br>**Main science idea(s):**<br>• The landforms on Earth's surface aren't the same everywhere. | Ask questions to elicit student ideas and predictions.<br><br>Link science ideas to other science ideas. | **Show slide 1.**<br><br>Last time, we looked at a relief map of the United States to identify landform patterns on the surface of Earth. What patterns did we notice?<br><br>**Show slide 2.**<br><br>So we agree that Earth's surface has a variety of landform patterns and that different areas have different kinds of landforms.<br><br>In the previous lesson, we also spent some time wondering about two questions:<br><br>1. Have the landforms on Earth's surface always looked the way they do now?<br>2. Will these landforms change in the future?<br><br>**Show slide 3.**<br><br>Let's review the list of ideas we came up with about ways Earth's surface might change over time. | It's flat in the middle of the country, and there are a lot of mountains in the west.<br><br>There are a lot of lakes up around Michigan.<br><br>California is flat in some places and also has mountains. | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | | | **NOTE TO TEACHER:** *Direct students' attention to the list of ideas you recorded on chart paper during the previous lesson (Ways Earth's Surface Might Change over Time).* | | |
| 1 min | **Lesson Focus Question**<br><br>**Synopsis:** The teacher introduces the focus question, *What happens to Earth's surface that causes mountains to form?* | Set the purpose with a focus question or goal statement. | **Show slide 4.**<br><br>Today we're going to continue our investigation of ways Earth's surface might change over time. One way the surface can change is the formation of mountains in different locations.<br><br>Our focus question for this lesson is *What happens to Earth's surface that causes mountains to form?*<br><br>Write this question in your science notebooks and draw a box around it.<br><br>**ELL support:** To clarify this question for ELL students, you might ask, "What happens to Earth's surface to create mountains?" or "How do mountains form?" or "What are the ways mountains form?"<br><br>**NOTE TO TEACHER:** *Write the focus question on the board for students to see and refer to throughout the lesson.* | | |
| 1 min | **Setup for Activity 1**<br><br>**Synopsis:** The teacher introduces the first activity in which students will investigate volcanoes and | Make explicit links between science ideas and activities **before** the activity. | Next, we'll see whether any of the ideas we came up with last time have anything to do with mountain formation.<br><br>**NOTE TO TEACHER:** *Use the introductory wording in option 1 or option 2* | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | consider whether they're involved in mountain building. | | *depending on whether volcanoes were listed on the class chart from lesson 1b.*<br>• ***Option 1:*** *If volcanoes* ***are*** *on the list from lesson 1b, say, "First, we'll consider the idea that volcanoes can help form, or build up, mountains."*<br>• ***Option 2:*** *If volcanoes* ***aren't*** *on the list, ask, "No one mentioned volcanoes last time. Do you think volcanoes might have anything to do with forming, or building, mountains? Why do you think so?"* | | |
| 8 min | **Activity 1**<br><br>**Synopsis**: Students look at pictures of volcanic eruptions and discuss the resulting changes on Earth's surface.<br>**Main science idea(s):**<br>• Volcanic eruptions change Earth's surface. These eruptions cause the land to build up over time and form mountains. | Make explicit links between science ideas and activities **during** the activity. | **Show slide 5.**<br><br>Look at the pictures of volcanoes on this slide.<br><br>Do these photos offer any evidence that volcanoes change the surface of Earth or are involved in building mountains? If so, how do you think this might happen?<br><br>Think about these questions for a moment as you look at the photos.<br><br>**ELL support:** This could be an opportunity for ELL students to develop some English vocabulary using terms like *volcano*, *lava*, *eruption*, and *flow*.<br><br>**NOTE TO TEACHER:** *Give students at least 30 seconds of think time before opening up the class discussion.*<br><br>**Individual think time.** | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | | Ask questions to probe student ideas and predictions. | **Whole-class discussion:** OK, let's talk about volcanoes. Do you think they change Earth's surface or might be involved in building mountains? And if so, how? Make sure to include evidence from the photographs in your responses. | Lava is flowing out of one volcano, and that changes Earth's surface.<br><br>The surface of Earth is covered with lava.<br><br>The lava turns into rock when it cools.<br><br>Yes, the surface is covered with a lot of new rock.<br><br>Yes. I think more rock will pile up.<br><br>It'll make the mountain taller. | Say more about how that changes Earth's surface.<br><br>Can anyone add to that idea?<br><br>Does that change Earth's surface?<br><br>Over a long period of time, do you think all that new rock will change the shape of the volcanic mountain?<br><br>How will that change the height of the mountain? |
| 5 min | **Follow-Up to Activity 1**<br><br>**Synopsis:** The teacher summarizes key ideas about volcanic activity and mountain building. | Make explicit links between science ideas and activities **after** the activity. | So we have some evidence from the volcano photos that Earth's surface changes over time. When volcanoes erupt, lava flows out of the opening, covers the ground, and then cools and hardens into rock. As new rocks form with each eruption, this changes Earth's | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | **Main science idea(s):**<br>• Volcanic eruptions are one way mountains form over time. As magma erupts, lava flows across the landscape and then cools into rock. Over time, these eruptions build up the land and form mountains. | Summarize key science ideas.<br><br>Engage students in analyzing and interpreting data and observations. | surface.<br><br>When a volcano erupts many, many times, rocks begin to pile up and gradually change the size and shape of the mountain.<br><br>**Show slide 6.**<br><br>Draw a picture in your notebooks showing how a volcano might change Earth's surface over time. Make sure to add labels to your diagrams using words from the word bank and then write a short description in your own words.<br><br>**Student drawing time.**<br><br>**Whole-class share-out:** Now I'd like a few of you to come up and share your drawings and descriptions with the class.<br><br>**Show slide 7.**<br><br>This slide shows a picture of a volcano that's no longer erupting and a picture of lava hardening into rock. After many eruptions, the lava from this volcano hardened and built up the mountain over a long period of time.<br><br>What do you think this volcanic mountain looked like when it erupted the very first time? | I think it was smaller.<br><br>Maybe the first time, lava just came out of a hole in the ground. | How small?<br><br>Tell us more about |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | | | How do you think the volcano changed over time? | After every eruption, it kept growing until it got really big and tall. | the lava. |
| 5 min | **Setup for Activity 2**<br><br>**Synopsis:** The teacher reviews the focus question and elicits student ideas about how Earth and a hard-boiled egg are alike and different.<br><br>**Main science idea(s):**<br>• Scientists often use models to learn about real objects. A hard-boiled egg can serve as a model of Earth. Even though we can't see inside Earth, a hard-boiled egg can help us understand Earth's crust. | Ask questions to elicit student ideas and predictions.<br><br>Make explicit links between science ideas and activities **before** the activity.<br><br>Highlight key science ideas and focus question throughout.<br><br>Select content | **Show slide 8.**<br><br>We've seen that volcanoes can change Earth's surface and build up mountains, but how exactly do mountains form?<br><br>And what about other mountains on Earth that aren't volcanoes? Where did they come from and how did they form?<br><br>Let's hear some of your ideas.<br><br>**Show slide 9.**<br><br>Next, we're going to investigate other ways that mountains can form on Earth's surface.<br><br>So be thinking about our focus question: *What happens to Earth's surface that causes mountains to form?*<br><br>By the end of the lesson, you should be able to describe some things that happen to Earth's surface that can cause mountains to form.<br><br>**Show slide 10.**<br><br>Let's start by comparing Earth's surface to | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | | representations and models matched to the learning goal and engage students in their use.<br><br>Ask questions to elicit student ideas and predictions. | this hard-boiled egg and see what we can learn about how mountains form.<br><br>In what ways is this egg different from Earth?<br><br>How is a hard-boiled egg similar to Earth?<br><br>**ELL support:** The comparison depends on students' knowledge. To level the playing field, you might consider using two eggs—one whole and one halved—and two Earths—one whole and one halved—so that students can see the interior of each. The point is to develop the comparison and language for understanding earth processes. If ELL students have experience with models (as analogies), it might also be helpful to emphasize that models are simplified systems. This will be important for students to keep in mind when ideas about Earth's crust are introduced later in the lesson.<br><br>**NOTE TO TEACHER:** *Instead of using a hard-boiled egg for this comparison, you could use a soccer ball, with the stitched sections representing plate boundaries.* | An egg is oval, and Earth is round.<br><br>An egg doesn't have mountains.<br><br>They both have solid stuff inside. | What makes you think this? What do you know about what's inside Earth? |
| 5 min | **Activity 2**<br><br>**Synopsis:** The teacher uses a cracked eggshell to demonstrate that Earth's | Select content representations and models matched to the learning goal and | Next, I'm going to crack this hard-boiled egg into pieces and pass a piece of eggshell around for you to look at.<br><br>**NOTE TO TEACHER:** ***Gently*** *crack the* | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | crust is very thin and is divided into interlocking plates.<br><br>**Main science idea(s):**<br>• The outermost surface of Earth is a very thin layer of cold, rigid rock composed of a number of separate but interlocking crustal plates. | engage students in their use.<br><br>Make explicit links between science ideas and activities **during** the activity. | *egg by tapping it on a desk. Try to break the shell into just a few pieces or sections. Carefully pull one piece of shell off the egg and pass it around for students to see how thin it is. (If the eggshell doesn't break into clearly defined interlocking sections that simulate tectonic plates, you may want to use the egg you cracked in advance.)*<br><br>The surface of a hard-boiled egg doesn't have any mountains, but its shell is similar to the outside layer of Earth in one important way: It's very thin.<br><br>We call the outside of Earth the *crust*—the same word we use for bread crust!<br><br>We stand on Earth's crust, so there is crust underneath us. But there is also crust underneath the oceans. Earth's surface layer is made up of all the continents and oceans, so it might seem very thick to us. But compared to the inside of Earth, the crust is very thin, like an eggshell.<br><br>**ELL support:** Clarify that *crust* also means "surface."<br><br>**Show slide 11.**<br><br>The diagram on this slide shows the different layers of Earth. Where do you think the crust is located? How do you think it's like an eggshell?<br><br>**NOTE TO TEACHER:** *Emphasize how thin* | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | | Highlight key science ideas and focus question throughout. | *the crust is in relationship to the interior of Earth.*<br><br>**Show slide 12.**<br><br>Earth's crust is like an eggshell because it's very thin compared to the inside layers of the planet.<br><br>Earth's crust is also like an eggshell in another very important way: It's broken into pieces, just like our cracked eggshell!<br><br>Scientists have figured out that Earth's crust is made up of interlocking pieces or sections called *tectonic plates* that fit together like pieces of a puzzle.<br><br>Let's look at our cracked eggshell again. How would you describe the pieces? Do they fit together like a puzzle?<br><br>**NOTE TO TEACHER:** *Make sure students understand that when the word* plates *is used in this lesson, it's referring to tectonic plates.* | | |
| 3 min | **Follow-Up to Activity 2**<br><br>**Synopsis:** Students summarize two ways Earth's crust and eggshells are alike.<br><br>**Main science idea:**<br>• The outermost surface of Earth is a very thin layer of cold, rigid rock composed of a number | Make explicit links between science ideas and activities **after** the activity.<br><br>Engage students in making connections by | **Show slide 13.**<br><br>What important science ideas did we discover from our investigation? How is Earth's crust like a hard-boiled egg?<br><br>**Turn and Talk:** Talk about these questions with a partner and summarize the key science ideas we discovered. We discussed two important ideas, but see if you can come up with any more. Be prepared to share these | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | of separate but interlocking crustal plates. | synthesizing and summarizing key science ideas.<br><br>Highlight key science ideas and focus question throughout. | ideas with the group.<br><br>**Whole-group share-out:** What key science ideas did we discover about Earth's crust? How is it like the shell of a hard-boiled egg?<br><br>**Show slide 14.**<br><br>Write down these important science ideas in your science notebooks:<br>• Earth's crust is thin.<br>• Earth's crust is made up of tectonic plates that fit together like puzzle pieces.<br><br>**NOTE TO TEACHER:** *In addition to having students copy these key science ideas into their notebooks, write them on chart paper so that students can see and refer to them in upcoming lessons.* | The crust is very thin like an eggshell, and they're both broken up into pieces.<br><br>Tectonic plates or plates. | What do we call the pieces of Earth's crust? |
| 6 min | **Synthesize/Summarize Today's Lesson**<br><br>**Synopsis:** Students discuss how today's activities relate to the lesson focus question.<br><br>**Main science idea(s):**<br>• Volcanic activity is one way mountains form. Other processes may | Highlight key science ideas and focus question throughout. | **Show slide 15.**<br><br>Our focus question for today is *What happens to Earth's surface that causes mountains to form?*<br><br>Let's review what we've learned from today's activities that might help us answer this question.<br><br>**NOTE TO TEACHER:** *During the* | | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | also be involved in mountain building. The thin crust of Earth is divided into plates that fit together like puzzle pieces. These crustal plates, called *tectonic plates*, may cause mountains to form, but we aren't sure how. | Summarize key science ideas. | *following discussion, write key science ideas on chart paper for students to refer to in upcoming lessons.*<br><br>***Embedded Assessment Task***<br><br>First, we looked at pictures of volcanoes. Did we learn anything from that activity about how mountains form? What is your evidence?<br><br>So we learned that volcanic eruptions build up mountains over a long period of time.<br><br>Next, we looked at a hard-boiled egg and a cracked eggshell. What did we learn from that activity about Earth's surface?<br><br>Do you think tectonic plates have anything to do with building mountains on Earth's surface? Why? | Yes, the lava flows out of the volcano and then forms rock when it cools. As the rocks pile up after each eruption, the mountain gets taller.<br><br>Earth's surface is called the *crust*, and it's very thin.<br><br>Earth's crust is broken up into pieces called *tectonic plates* that fit together like a puzzle.<br><br>No, because Earth's surface is like an eggshell, and there are no | What else did we learn?<br><br>Tell us more about tectonic plates. |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
|---|---|---|---|---|---|
| | | | So we're not sure tectonic plates have anything to do with building mountains on Earth's surface.<br><br>Let's jot this down as a "wondering" on chart paper and in your science notebooks: We wonder whether Earth's tectonic plates might be involved in building mountains on Earth's surface. | mountains on eggshells!<br><br>I've heard of tectonic plates, and I think they move somehow and cause earthquakes.<br><br>I don't think the plates have anything to do with mountains. It's confusing. | Does anyone disagree or want to add something? |
| 1 min | **Link to Next Lesson**<br><br>**Synopsis:** The teacher links key science ideas to the next lesson. | Summarize key science ideas.<br><br>Link science ideas to other science ideas. | **Show slide 16.**<br><br>Today we discovered that volcanic eruptions can build mountains. We also learned that Earth's crust is very thin and is made of sections called *tectonic plates* that fit together like pieces of a jigsaw puzzle.<br><br>But we're still wondering about whether these plates might be involved in building mountains on Earth's surface.<br><br>Next time we'll gather more information to help us figure out this "wondering" of ours. | | |