

## Grade 7 Science, Unit 8

# Earth Systems

### Overview

#### Unit abstract

Students examine geoscience data in order to understand processes and events in Earth’s history. Important concepts in this topic are “Scale, Proportion, and Quantity,” “Stability and Change,” and “Patterns,” in relation to the different ways geologic processes operate over the long expanse of geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth’s systems. Students understand how Earth’s geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students can investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data. Students are expected to demonstrate proficiency in analyzing and interpreting data and constructing explanations, and they are expected to use these practices to demonstrate understanding of the core ideas.

#### Essential questions

- How do people figure out that the Earth and life on Earth have changed over time?
- How does the movement of tectonic plates affect the surface of Earth?
- How do the materials in and on Earth’s crust change over time?

## Written Curriculum

### Next Generation Science Standards

<b>MS. History of Earth</b>		
<p>Students who demonstrate understanding can:</p> <p><b>MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history.</b> [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth’s history. Examples of Earth’s major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]</p>		
<p>The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i>:</p>		
<p style="text-align: center;"><b>Science and Engineering Practices</b></p> <p><b>Constructing Explanations and Designing Solutions</b></p> <p>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> <li>Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4)</li> </ul>	<p style="text-align: center;"><b>Disciplinary Core Ideas</b></p> <p><b>ESS1.C: The History of Planet Earth</b></p> <ul style="list-style-type: none"> <li>The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)</li> </ul>	<p style="text-align: center;"><b>Crosscutting Concepts</b></p> <p><b>Scale Proportion and Quantity</b></p> <ul style="list-style-type: none"> <li>Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-4)</li> </ul>
<p><i>Connections to other DCIs in this grade-band:</i> <b>MS.LS4.A</b> (MS-ESS1-4); <b>MS.LS4.C</b> (MS-ESS1-4)</p>		
<p><i>Articulation of DCIs across grade-bands:</i> <b>3.LS4.A</b> (MS-ESS1-4); <b>3.LS4.C</b> (MS-ESS1-4); <b>4.ESS1.C</b> (MS-ESS1-4); <b>HS.PS1.C</b> (MS-ESS1-4); <b>HS.LS4.A</b> (MS-ESS1-4); <b>HS.LS4.C</b> (MS-ESS1-4); <b>HS.ESS1.C</b> (MS-ESS1-4); <b>HS.ESS2.A</b> (MS-ESS1-4)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p><b>RST.6-8.1</b> Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-4)</p> <p><b>WHST.6-8.2</b> Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-4)</p> <p><i>Mathematics –</i></p> <p><b>6.EE.B.6</b> Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-4)</p> <p><b>7.EE.B.4</b> Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-4)</p>		

<b>MS. Earth's Systems</b>		
Students who demonstrate understanding can: <b>MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.</b> [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<b>Science and Engineering Practices</b>	<b>Disciplinary Core Ideas</b>	<b>Crosscutting Concepts</b>
<b>Developing and Using Models</b> Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena. (MS-ESS2-1)</li> </ul>	<b>ESS2.A: Earth's Materials and Systems</b> <ul style="list-style-type: none"> <li>All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)</li> </ul>	<b>Stability and Change</b> <ul style="list-style-type: none"> <li>Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1)</li> </ul>
<i>Connections to other DCIs in this grade-band:</i> <b>MS.PS1.A</b> (MS-ESS2-1); <b>MS.PS1.B</b> (MS-ESS2-1); <b>MS.PS3.B</b> (MS-ESS2-1); <b>MS.LS2.B</b> (MS-ESS2-1); <b>MS.LS2.C</b> (MS-ESS2-1); <b>MS.ESS1.B</b> (MS-ESS2-1); <b>MS.ESS3.C</b> (MS-ESS2-1)		
<i>Articulation of DCIs across grade-bands:</i> <b>4.PS3.B</b> (MS-ESS2-1); <b>4.ESS2.A</b> (MS-ESS2-1); <b>5.ESS2.A</b> (MS-ESS2-1); <b>HS.PS1.B</b> (MS-ESS2-1); <b>HS.PS3.B</b> (MS-ESS2-1); <b>HS.LS1.C</b> (MS-ESS2-1); <b>HS.LS2.B</b> (MS-ESS2-1); <b>HS.ESS2.A</b> (MS-ESS2-1); <b>HS.ESS2.C</b> (MS-ESS2-1); <b>HS.ESS2.E</b> (MS-ESS2-1)		
<i>Common Core State Standards Connections:</i> <i>ELA/Literacy –</i> <b>SL.8.5</b> Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-1)		

<b>MS. History of Earth</b>		
Students who demonstrate understanding can:		
<b>MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.</b> [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<b>Science and Engineering Practices</b> <b>Constructing Explanations and Designing Solutions</b> Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. <ul style="list-style-type: none"> <li>Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS2-2)</li> </ul>	<b>Disciplinary Core Ideas</b> <b>ESS2.A: Earth's Materials and Systems</b> <ul style="list-style-type: none"> <li>The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)</li> </ul> <b>ESS2.C: The Roles of Water in Earth's Surface Processes</b> <ul style="list-style-type: none"> <li>Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)</li> </ul>	<b>Crosscutting Concepts</b> <b>Scale Proportion and Quantity</b> <ul style="list-style-type: none"> <li>Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS2-2)</li> </ul>
<i>Connections to other DCIs in this grade-band:</i> <b>MS.PS1.B</b> (MS-ESS2-2); <b>MS.LS2.B</b> (MS-ESS2-2)		
<i>Articulation of DCIs across grade-bands:</i> <b>4.ESS1.C</b> (MS-ESS2-2); <b>4.ESS2.A</b> (MS-ESS2-2); <b>4.ESS2.E</b> (MS-ESS2-2); <b>5.ESS2.A</b> (MS-ESS2-2); <b>HS.PS3.D</b> (MS-ESS2-2); <b>HS.LS2.B</b> (MS-ESS2-2); <b>HS.ESS1.C</b> (MS-ESS2-2); <b>HS.ESS2.A</b> (MS-ESS2-2); <b>HS.ESS2.B</b> (MS-ESS2-2); <b>HS.ESS2.C</b> (MS-ESS2-2); <b>HS.ESS2.D</b> (MS-ESS2-2); <b>HS.ESS2.E</b> (MS-ESS2-2); <b>HS.ESS3.D</b> (MS-ESS2-2)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
<b>RST.6-8.1</b>	Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2)	
<b>WHST.6-8.2</b>	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS2-2)	
<b>SL.8.5</b>	Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. (MS-ESS2-2)	
<i>Mathematics –</i>		
<b>MP.2</b>	Reason abstractly and quantitatively. (MS-ESS2-2)	
<b>6.EE.B.6</b>	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS2-2)	
<b>7.EE.B.4</b>	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS2-2)	

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<b>MS. History of Earth</b>		
Students who demonstrate understanding can:		
<b>MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.</b> [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<b>Science and Engineering Practices</b>	<b>Disciplinary Core Ideas</b>	<b>Crosscutting Concepts</b>
<p><b>Analyzing and Interpreting Data</b> Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</p> <ul style="list-style-type: none"> <li>Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3)</li> </ul> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Open to Revision in Light of New Evidence</b></p> <ul style="list-style-type: none"> <li>Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)</li> </ul>	<p><b>ESS1.C: The History of Planet Earth</b></p> <ul style="list-style-type: none"> <li>Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (<i>HS.ESS1.C GBE</i>) (<i>secondary to MS-ESS2-3</i>)</li> </ul> <p><b>ESS2.B: Plate Tectonics and Large-Scale System Interactions</b></p> <ul style="list-style-type: none"> <li>Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart. (MS-ESS2-3)</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3)</li> </ul>
<i>Connections to other DCIs in this grade-band: MS.LS4.A (MS-ESS2-3)</i>		
<i>Articulation of DCIs across grade-bands: 3.LS4.A (MS-ESS2-3); 3.ESS3.B (MS-ESS2-3); 4.ESS1.C (MS-ESS2-3); 4.ESS2.B (MS-ESS2-3); 4.ESS3.B (MS-ESS2-3); HS.LS4.A (MS-ESS2-3); HS.LS4.C (MS-ESS2-3); HS.ESS1.C (MS-ESS2-3); HS.ESS2.A (MS-ESS2-3); HS.ESS2.B (MS-ESS2-3)</i>		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
<b>RST.6-8.1</b>	Cite specific textual evidence to support analysis of science and technical texts. ( <i>MS-ESS2-3</i> )	
<b>RST.6-8.7</b>	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). (MS-ESS2-3)	
<b>RST.6-8.9</b>	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3)	
<i>Mathematics –</i>		
<b>MP.2</b>	Reason abstractly and quantitatively. (MS-ESS2-3)	
<b>6.EE.B.6</b>	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. ( <i>MS-ESS2-3</i> )	
<b>7.EE.B.4</b>	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. ( <i>MS-ESS2-3</i> )	

## Clarifying the standards

### *Prior learning*

The following disciplinary core ideas are prior learning for the concepts in this unit of study.

By the end of Grade 5, students know that:

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere.
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.
- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.
- A variety of natural hazards result from natural processes.
- Humans cannot eliminate natural hazards but can take steps to reduce their impacts.
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.
- The presence and location of certain fossil types indicate the order in which rock layers were formed.
- Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.
- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns.
- Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.
- Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth.
- Living things affect the physical characteristics of their regions.
- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions).
- Humans cannot eliminate the hazards but can take steps to reduce their impacts.

***Progression of current learning*****Driving question 1**

What scientific evidence found in rock strata can be used to explain how the geologic time scale is used to organize Earth's 4.6-billion-year-old history?

**Concepts**

- The geologic time scale is used to organize Earth's 4.6-billion-year-old history.
- Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history.
- The geologic time scale interpreted from rock strata provides a way to organize Earth's history.
- Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

**Practices**

- Construct a scientific explanation.
- Construct a scientific explanation based on valid and reliable evidence from rock strata obtained from sources (including the students' own experiments).
- Construct a scientific explanation based on rock strata and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

**Driving question 2**

What drives the cycling of Earth's materials?

**Concepts**

- Energy drives the process that results in the cycling of Earth's materials.
- The processes of melting, crystallization, weathering, deformation, and sedimentation act together to form minerals and rocks through the cycling of Earth's materials.
- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems.
- Energy flowing and matter cycling within and among the planet's systems derive from the sun and Earth's hot interior.
- Energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.

**Practices**

- Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

- Explanations of stability and change in Earth’s natural systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.

### Driving question 3

How have geoscience processes changed Earth’s surface at varying time and spatial scales?

#### Concepts

- Geoscience processes have changed Earth’s surface at varying time and spatial scales.
- Processes change Earth’s surface at time and spatial scales that can be large or small; many geoscience processes usually behave gradually but are punctuated by catastrophic events.
- Geoscience processes shape local geographic features.
- The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years.
- Interactions among Earth’s systems have shaped Earth’s history and will determine its future.
- Water’s movements—both on the land and underground—cause weathering and erosion, which change the land’s surface features and create underground formations.
- Time, space, and energy phenomena within Earth’s systems can be observed at various scales using models to study systems that are too large or too small.

#### Practices

- Construct a scientific explanation for how geoscience processes have changed Earth’s surface at varying time and spatial scales based on valid and reliable evidence obtained from sources (including the students’ own experiments).
- Construct a scientific explanation for how geoscience processes have changed Earth’s surface at varying time and spatial scales based on the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Collect evidence about processes that change Earth’s surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges).
- Collect evidence about processes that change Earth’s surface at time and spatial scales that can be small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events.



**Driving question 4**

How does the distribution of fossils and rocks, continental shapes, and seafloor structures provide evidence of past plate motions?

**Concepts**

- Tectonic processes continually generate new sea floor at ridges and destroy old sea floor at trenches.
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.
- Patterns in rates of change and other numerical relationships can provide information about past plate motions.
- The distribution of fossils and rocks, continental shapes, and sea floor structures to provide evidence of past plate motions.
- Similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches) provide evidence of past plate motions.

**Practices**

- Analyze and interpret data such as distributions of fossils and rocks, continental shapes, and sea floor structures to provide evidence of past plate motions.
- Analyze how science findings have been revised and/or reinterpreted based on new evidence about past plate motions.

**Integration of content, practices, and crosscutting concepts**

Within this unit, students will use the geologic time scale to organize Earth's 4.6-billion-year-old history. They will cite specific textual evidence from science and technical texts to support analysis of rock strata to show how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. They will use analysis of rock formations and the fossils they contain to establish relative ages of major events in Earth's history. Examples of Earth's major events could include the Ice Age or the earliest fossils of *Homo sapiens*, or the formation of Earth and the earliest evidence of life. Emphasis should be on analyses of rock strata providing only relative dates, not an absolute scale. Students can use variables to represent numbers or quantities and write expressions when solving problems while constructing their explanations. Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions. *Note:* Assessment does not include recalling the names of specific periods or epochs and events within them.

Students will develop and use models to describe the cycling of Earth materials and the flow of energy that drives this process. This energy comes from the heat of the core of the Earth, which is transferred to the mantle. Convection currents within the mantle then drive the movement of tectonic plates. Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials. Students can generate models to demonstrate the rock cycle, with specific focus on the processes causing change. Students can analyze pictures and rock samples that demonstrate various processes of melting, crystallization, weathering, deformation, and sedimentation. Students are not identifying and naming minerals within this unit.

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Students will construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions). Further emphasis is on how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Students can gather data and plot volcanoes and earthquakes in order to collect evidence to support the idea that these interactions among Earth's systems have shaped Earth's history and will determine its future. Additional examples can include changes on Earth's surface from weathering and deposition by the movements of water, ice, and wind. Emphasis is also on geoscience processes that shape local geographic features, such as the Rhode Island shoreline.

Students convey ideas, concepts, and information through the selection, organization, and analysis of relevant content, and they may use multimedia components and visual displays. Students can also compare and contrast the information gained from experiments, simulations, video, or multimedia sources showing evidence of past plate motion with that gained by reading a text on the same topic. They use informative/explanatory texts to examine evidence for how geoscience processes have changed and reason abstractly and quantitatively when analyzing this evidence. They may integrate quantitative or technical information expressed in a flowchart, diagram, model, graph, or table. They can also use variables to represent numbers or quantities and write expressions when solving problems while constructing their explanations.

Students will analyze and interpret data on the distribution of fossils and rocks, and they will look at the continental shapes and sea floor structures to provide evidence of past plate motions. Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. Examples of the data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches). Students may use numerical relationships, symbols, and words while analyzing patterns in rates of change on Earth's crust. Students can use variables to represent numerical data and write expressions or construct simple equations and inequalities when solving a problems involved in the analysis of data about past plate motions. Applying interpreted data on the distribution of fossils and rocks, continental shapes, and sea floor structures, students can provide evidence of past plate motions. Students are not analyzing paleomagnetic anomalies in oceanic and continental crust.

### *Integration of DCI from prior units within this grade level*

Content within this unit builds upon student learning from Unit 1, Structure and Properties of Matter, and Unit 2, Interactions of Matter.

### *Integration of mathematics and English language arts/literacy*

#### *Mathematics*

- Use variables to represent numbers and write expressions when solving problems while constructing explanations from evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history; understand that a variable can represent an unknown number or, depending on the purpose at hand, any number in a specific set.
- Use variables to represent quantities in a real-world or mathematical problem when solving problems while constructing explanations from evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

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- Reason abstractly and quantitatively when analyzing evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
- Use variables to represent numbers and write expressions when solving a real-world or mathematical problem involving evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. Understand that a variable can represent an unknown number or, depending on the purpose at hand, any number in a specified set.
- Use variables to represent quantities in a real-world or mathematical problem involving evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales, and construct simple equations and inequalities to solve problems by reasoning about the quantities.
- Use numbers, symbols, and words while analyzing and interpreting data on the distribution of fossils and rocks, continental shapes, and sea floor structures to provide evidence of past plate motions.
- Use variables to represent numerical data and write expressions when solving a problems involved in the analysis of data about past plate motions. Understand that a variable can represent an unknown number or, depending on the purpose at hand, any number in a specified set.
- Use variables to represent quantities when analyzing data about past plate motions and construct simple equations and inequalities to solve problems by reasoning about the quantities.

### *English language arts/literacy*

- Cite specific textual evidence based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history to support analysis of science and technical texts.
- Write informative/explanatory texts to examine evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion-year-old history and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- Cite specific textual evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales to support analysis of science and technical texts.
- Use informative/explanatory texts to examine evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- Include multimedia components and visual displays in presentations about evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales to clarify claims and findings and emphasize salient points.
- Cite specific textual evidence of past plate motion to support analysis of science texts.
- Integrate quantitative or technical information about evidence of past plate motions expressed in words in a text with a version of that information expressed in a flowchart, diagram, model, graph, or table.
- Compare and contrast the information gained from experiments, simulations, video, or multimedia sources showing evidence of past plate motion with that gained from reading a text on the same topic.

## ***Future learning***

### *Physical science*

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.
- The total number of neutrons plus protons does not change in any nuclear process.
- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

### *Life science*

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web.
- Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded.
- The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways.
- At each link in an ecosystem, matter and energy are conserved.
- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
- Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.
- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.
- Natural selection leads to adaptation—that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait lead to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
- Adaptation also means that the distribution of traits in a population can change when conditions change.

- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.

### *Earth and space science*

- Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.
- Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years.
- Studying these objects can provide information about Earth's formation and early history.
- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities.
- These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.
- The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection.
- Plate tectonics can be viewed as the surface expression of mantle convection.
- Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history.
- Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust.
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.
- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.
- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

## Number of Instructional Days

*Recommended number of instructional days: 30 (1 day = approximately 50 minutes)*

**Note**—The recommended number of days is an estimate based on the information available at this time. Teachers are strongly encouraged to review the entire unit of study carefully and collaboratively to determine whether adjustments to this estimate need to be made.