

Unit Summary

If no one was there, how do we know the Earth's history?

What provides the forces that drive Earth's systems?

Students examine geoscience data in order to understand processes and events in Earth's history. Important crosscutting concepts in this unit are *scale, proportion, and quantity, stability and change, and patterns* in relation to the different ways geologic processes operate over 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 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*. They are also expected to use these practices to demonstrate understanding of the core ideas.

Student Learning Objectives

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. *[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.]* [\(MS-ESS1-4\)](#)

Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. *[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.]* [\(MS-ESS2-1\)](#)

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. *[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.]* [\(MS-ESS2-2\)](#)

Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. *[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.]* [\(MS-ESS2-3\)](#)

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Unit Sequence	
Part A: How do we know that the Earth is approximately 4.6-billion-year-old history?	
Concepts	Formative Assessment
<ul style="list-style-type: none"> 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. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> 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.

Unit Sequence	
Part B: What drives the cycling of Earth’s materials?	
Concepts	Formative Assessment
<ul style="list-style-type: none"> 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. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.

<ul style="list-style-type: none"> • 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. • 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. 	
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Unit Sequence	
<i>Part C: Do all of the changes to Earth systems occur in similar time scales?</i>	
Concepts	Formative Assessment
<ul style="list-style-type: none"> • 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. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • 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.

Unit Sequence	
Part D: How is it possible for the same kind of fossils to be found in New Jersey and in Africa?	
Concepts	Formative Assessment
<ul style="list-style-type: none"> 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. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> 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.

What It Looks Like in the Classroom
<p>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. <i>[Note: Assessment does not include recalling the names of specific periods or epochs and events within them.]</i></p> <p>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. <i>[Note: Students are not identifying and naming minerals within this unit].</i></p> <p>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</p>

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 [New Jersey's Ridge and Valley Province, Highlands, Piedmont, and Coastal Plain](#).

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. *[Note: Students are not analyzing paleomagnetic anomalies in oceanic and continental crust in this unit].*

Connecting with English Language Arts/Literacy and Mathematics

English Language Arts

- 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.

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.
- 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.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: [All Standards, All Students/Case Studies for vignettes and explanations of the modifications.](#))

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community)

helping with a project, journal articles, and biographies).

- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#VXmoXcfD_UA).

Research on Student Learning

Students of all ages may hold the view that the world was always as it is now, or that any changes that have occurred must have been sudden and comprehensive. The students in these studies did not, however, have any formal instruction on the topics investigated. Moreover, students taught by traditional means are not able to construct coherent explanations about the causes of volcanoes and earthquakes.

Few students understand the molecular basis of heat conduction even after instruction. For example, students attribute to particles properties such as "hotness" and "coldness" or believe that heat is produced by particles rubbing against each other. During instruction, students use ideas that give heat an active drive or intent to explain observations of convection currents. They also draw parallels between evaporation and the water cycle and convection, sometimes explicitly explaining the upwards motion of convection currents as evaporation.

Students rarely think energy is measurable and quantifiable. Students' alternative conceptualizations of energy influence their interpretations of textbook representations of energy.

Students tend to think that energy transformations involve only one form of energy at a time. Although they develop some skill in identifying different forms of energy, in most cases their descriptions of energy-change focus only on forms which have perceivable effects. The transformation of motion to heat seems to be difficult for students to accept, especially in cases with no temperature increase. Finally, it may not be clear to students that some forms of energy, such as light, sound, and chemical energy, can be used to make things happen.

The idea of energy conservation seems counterintuitive to middle- and high-school students who hold on to the everyday use of the term energy, but teaching heat dissipation ideas at the same time as energy conservation ideas may help alleviate this difficulty. Even after instruction, however, students do not seem to appreciate that energy conservation is a useful way to explain phenomena. A key difficulty students have in understanding conservation appears to derive from not considering the appropriate system and environment. In addition, middle- and high-school students tend to use their conceptualizations of energy to interpret energy conservation ideas. For example, some students interpret the idea that "energy is not created or destroyed" to mean that energy is stored up in the system and can even be released again in its original form. Or, students may believe that no energy remains at the end of a process, but may say that "energy is not lost" because an effect was caused during the process (for example, a weight was lifted). Although teaching approaches which accommodate students' difficulties about energy

appear to be more successful than traditional science instruction, the main deficiencies outlined above remain despite these approaches ([NSDL, 2015](#)).

Prior Learning

By the end of Grade 5, students understand 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.

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.

Connections to Other Units

Grade 7 Unit 1: Structure and Properties of Matter

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

Grade 7 Unit 2: Interactions of Matter

- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.

Grade 7 Unit 3: Chemical Reactions

- The total number of each type of atom is conserved, and thus the mass does not change.
- Some chemical reactions release energy, others store energy.

Grade 8 Unit 4: Human Impacts on Earth Systems and Global Climate Change

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

Grade 8 Unit 5: Relationships among Forms of Energy

- A system of objects may also contain stored (potential) energy, depending on their relative positions.
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

Grade 7 Unit 8: Earth Systems

- 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.
- 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.

Sample of Open Education Resources

[Rock Cycle Journey](#): This is an activity out of one of the DLESE Teaching boxes. The Teaching Box is titled Mountain Building. This activity is from Lesson 4 Activity #2 called Rock Cycle Journey. Stations are set up to represent different parts of the rock cycle. There is a die at each station. Students begin at one point and roll the die. The students record on their data sheet what happens to them (the rock). The student may end up staying where they are at or going to another station. Students continue individually through a set number of rolls of the dice. Students then look at their data and answer some questions. At the very end they share their information with others.

[Interactives-Dynamic Earth](#): Dynamic Earth is an interactive website where students can learn about the structure of the Earth, the movements of its tectonic plates, as well as the forces that create mountains, valleys, volcanoes and earthquakes. This site consists of four sections with both embedded assessments to check progress and a final summative assessment. Each section explores one aspect of the earth's structure and the movement of its tectonic plates. The instructions are simple and are located on each screen. Students will view animations, read explanations, and use their mouse to drag and drop the earth's continents into the correct places, highlight features on a map and cause earth's tectonic plates to move. At various points, students will check their knowledge by taking a quick quiz or playing a game to see how much they have learned about the Dynamic Earth. This website does have teacher information tabs located as related resources.

Appendix A: NGSS and Foundations for the Unit		
<p>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. <i>[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.]</i> <i>[Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]</i> (MS-ESS1-4)</p>		
<p>Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. <i>[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.]</i> <i>[Assessment Boundary: Assessment does not include the identification and naming of minerals.]</i> (MS-ESS2-1)</p>		
<p>Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. <i>[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.]</i> (MS-ESS2-2)</p>		
<p>Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. <i>[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).]</i> <i>[Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]</i> (MS-ESS2-3)</p>		
<p>The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</p>		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop and use a model to describe phenomena. (MS-ESS2-1) <p>Constructing Explanations and Designing Solutions</p> <ul style="list-style-type: none"> 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 nature operate today as they did in the past and will continue to do so in the future. 	<p>ESS1.C: The History of Planet Earth</p> <ul style="list-style-type: none"> 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) <p>ESS2.A: Earth's Materials and Systems</p> <ul style="list-style-type: none"> 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 	<p>Stability and Change</p> <ul style="list-style-type: none"> 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) <p>Scale Proportion and Quantity</p> <ul style="list-style-type: none"> Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-

<p>(MS-ESS1-4),(MS-ESS2-2)</p> <p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3) 	<p>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)</p> <ul style="list-style-type: none"> 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) <p>ESS2.B: Plate Tectonics and Large-Scale System Interactions</p> <ul style="list-style-type: none"> 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) 	<p>ESS1-4),(MS-ESS2-2)</p> <p>Patterns</p> <ul style="list-style-type: none"> Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3) <p>-----</p> <p>Connections to Nature of Science</p> <p>Scientific Knowledge is Open to Revision in Light of New Evidence</p> <ul style="list-style-type: none"> Science findings are frequently revised and/or reinterpreted based on new evidence. (MS-ESS2-3)
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English Language Arts	Mathematics
<p>Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-4),(MS-ESS2-2) RST.6-8.1</p> <p>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),(MS-ESS2-2) WHST.6-8.2</p> <p>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) RST.6-8.7</p> <p>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) RST.6-8.9</p> <p>Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1),(MS-ESS2-2) SL.8.5</p>	<p>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),(MS-ESS2-3) 7.EE.B.4</p> <p>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),(MS-ESS2-2),(MS-ESS2-3) 6.EE.B.6</p> <p>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) 7.EE.B.6</p> <p>Reason abstractly and quantitatively. (MS-ESS2-2),(MS-ESS2-3) MP.2</p>