NGSS OVERVIEW

GEOLOGICAL PROCESSES

Performance Expectation MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Performance Expectation MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Performance Expectation 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.

Performance Expectation MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Performance Expectation MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1. **Talking It Over: Storing Nuclear Waste** Students are introduced to the compelling issue of determining a central location to store nuclear waste in the United States. In the activity, they learn about nuclear waste and begin to consider the challenges associated with storing radioactive material. The activity elicits students' initial ideas about natural hazards, which could have an impact on safety of a nuclear waste storage site. The crosscutting concept of *patterns* helps students make sense of the data presented in this activity.	MS-ESS3.B	Analyzing and Interpreting Data Asking Questions and Defining Problems Obtaining, Evaluating, and Communicating Information	Patterns Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Connections to Nature of Science: Science Addresses Questions about the Natural and Material World	Mathematics: MP.2 ELA/Literacy: RST.6-8.1
2. **Investigation: Investigating Groundwater** Students carry out an investigation to learn how water enters and flows through earth materials. They *analyze and interpret the data* they collect as they compare two different earth materials. In doing so, they learn that aquifers form in locations with certain geological features. Students then reconsider the issue of where to store nuclear waste as they examine a map showing the uneven distribution of aquifers across the contiguous United States.	MS-ESS2.A MS-ESS2.C MS-ESS3.A	Analyzing and Interpreting Data Developing and Using Models Planning and Carrying Out Investigations	Structure and Function Systems and System Models	ELA/Literacy: RST.6-8.3

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
3. **View and Reflect: Modeling Landslides** Students learn how scientists use models and technology to develop an understanding of the phenomenon of landslides. They watch and discuss a video showing a team of scientists *using a model* to investigate how and why landslides happen.	MS-ESS2.A MS-ESS2.C MS-ESS3.B	Developing and Using Models Constructing Explanations and Designing Solutions	Cause and Effect Systems and System Models Scale, Proportion, and Quantity Stability and Change	
4. **Reading: Natural Hazards Caused by Earthquakes and Volcanoes** Students *obtain and evaluate information* by reading cases of real geological events. In doing so, they learn about natural hazards caused by earthquakes and volcanoes, as well as how these natural hazards are monitored and the destruction caused by them can be mitigated.	MS-ESS2.A MS-ESS3.B	Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information Engaging in Argument from Evidence	Cause and Effect Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	ELA/Literacy: RST.6-8.1 RST.6-8.2 WHST.6-8.9
5. **Modeling: Modeling Volcanic Eruptions** Students *use a model* to understand what happens during a volcanic eruption. By *analyzing and interpreting the data* from the model, students learn how the amount of gas in the magma that feeds a volcano can result in more- or less-explosive eruptions. Students consider how the type of eruption might affect the type of igneous rock formed.	MS-ESS2.A	Constructing Explanations and Designing Solutions Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data	Cause and Effect Scale, Proportion, and Quantity Systems and System Models	ELA/Literacy: RST.6-8.3
6. **Investigation: Mapping Locations of Earthquakes and Volcanoes** In previous activities, students learned about hazards associated with earthquakes and volcanoes. In this activity, students use the science and engineering practice of *analyzing and interpreting data* as they map the locations of significant earthquakes and major volcanoes around the world. They look for *patterns* in the distribution of earthquakes and volcanoes as a first step in discovering that Earth's surface is broken into plates. In subsequent activities, students build on this knowledge as they learn about plate movement, its causes, and the effects.	MS-ESS2.A MS-ESS3.B	Analyzing and Interpreting Data Asking Questions and Defining Problems Using Mathematics and Computational Thinking	Patterns Systems and System Models Connections to Nature of Science; Scientific Knowledge Assumes an Order and Consistency in Natural Systems	ELA/Literacy: SL.8.1

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
7. **Problem Solving: Observing Earth's Moving Surface** In this activity, students learn how to *analyze and interpret data* from GPS measurements over time, which they use to determine the rate and direction of tectonic plate movement. They work collaboratively in groups and then share their findings. While students do not provide explanations for the motions shown in the GPS data in this activity, the analyzed data display the types of plate boundary interactions students will encounter in subsequent activities.	MS-ESS2.A MS-ESS3.B	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions	Patterns Scale, Proportion, and Quantity Stability and Change Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World	Mathematics: MP.4 6.NS.C.5 ELA/Literacy: SL.8.1
8. **Reading: Beneath Earth's Surface** Through a reading about the structure of Earth's interior, students *obtain information* about how Earth's surface is broken into lithospheric plates that move. They integrate information from the reading and a table of data about Earth's layers to create a scale model of Earth's interior.	MS-ESS2.A MS-ESS2.B	Developing and Using Models Analyzing and Interpreting Data Using Mathematics and Computational Thinking Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence	Patterns Scale, Proportion, and Quantity Structure and Function Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Connections to Nature of Science: Science Is a Human Endeavor	Mathematics: 6.RP.A.1 ELA/Literacy: RST.6-8.3 RST.6-8.4

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
9. **Modeling: Modeling Earthquakes** In previous activities, students have learned that earthquakes occur at plate boundaries, and that some plates move apart, some move toward each other, and move past each other. In this activity, students *plan and carry out an investigation* using a model to simulate the buildup and release of energy in an earthquake. They investigate *cause-and-effect relationships* as they choose variables to change in the model.	MS-ESS2.A	Asking Questions and Defining Problems Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Construction Explanations and Designing Solutions	Cause and Effect Scale, Proportion, and Quantity Systems and System Models Energy and Matter Stability and Change	ELA/Literacy: RST.6-8.3
10. **Computer Simulation: Plate Boundaries** Students *use a model* to observe the changes to Earth's lithosphere at plate boundaries. By carefully observing a computer simulation, students investigate how Earth's surface changes over time due to geological processes caused by plate motion. Students *analyze and interpret data* from the computer simulation to identify the similarities and differences between the geological processes that happen at the three plate boundaries.	MS-ESS2.A MS-ESS2.B MS-ESS1.C	Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions	Patterns Cause and Effect Scale, Proportion, and Quantity Systems and System Models Stability and Change	ELA/Literacy: SL.8.1
11. **Reading: Understanding Plate Boundaries** Students read about the geological processes that shape Earth's surface near plate boundaries. They consider how these geological processes have changed Earth's surface at varying time and spatial scales. They apply their understanding of the geological processes happening at plate boundaries and their associated natural hazards to the nuclear waste issue.	MS-ESS2.A MS-ESS1.C MS-ESS3.B	Analyzing and Interpreting data Engaging in Argument from Evidence	Cause and Effect Stability and Change	ELA/Literacy: RST.6-8.2 WHST.6-8.1

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
12. **Investigation: The Continent Puzzle** Students *analyze and interpret data* about continent shapes, as well as fossil and rock information from different continents. Students use the *patterns* found in this data as evidence to explain that the continents have moved great distances, collided, and spread apart over geological time.	MS-ESS1.C MS-ESS2.A MS-ESS2.B	Developing and Using Models Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations Engaging in Argument from Evidence Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns Scale, Proportion, and Quantity Stability and Change Connections to Nature of Science: Science Is a Human Endeavor Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Mathematics: 6.RP.A.1 7.RP.A.2 ELA/Literacy: SL.8.1 WHST.6-8.1
13. **View and Reflect: The Theory of Plate Tectonics** Students learn about the development of the theory of plate tectonics, beginning with a review of the fossil and geological evidence that led to Alfred Wegener's ideas about continental drift. Through watching and discussing a video, students see that scientific knowledge is based on empirical evidence and that scientific findings are subject to revision as new evidence becomes available. Finally, students use the evidence they've collected throughout the unit to construct an explanation about how plate tectonic processes have shaped Earth's surface at different spatial and time scales. This activity provides an assessment opportunity for Performance Expectation MS-ESS2-2.	MS-ESS1.C MS-ESS2.A MS-ESS2.B	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence	Patterns Scale, Proportion, and Quantity Stability and Change Connections to Nature of Science: Science Is a Human Endeavor Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	ELA/Literacy: WHST.6-8.2

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
14. **Laboratory: What Makes the Plates Move?** Students learn about the flow of energy and the forces that are thought to drive the movement of Earth's lithospheric plates. They *use a model* to discover the conditions necessary for convection to take place, and relate their findings to the flow of energy and resulting movement in Earth's interior. Students also *use a model* to learn about the role of gravity in plate motion. This activity provides a formal assessment opportunity for Performance Expectation MS-ESS2-3.	MS-ESS1.C MS-ESS2.A MS-ESS2.B	Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence	Patterns Cause and Effect Scale, Proportion, and Quantity Systems and System Models Energy and Matter Structure and Function Stability and Change Connections to Nature of Science: Science Is a Human Endeavor Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Mathematics: MP.2 ELA/Literacy: WHST.6-8.2
15. **Investigation: The Rock Cycle** Throughout the unit, students have learned about many geological processes that have changed Earth's surface at varying time and spatial scales. In this activity, students use a model to connect the cycling of earth materials to the geological processes that result in the formation of different kinds of rock. Students also consider how the flow of energy drives various geological processes that form rock. Finally, students develop a model that describes the cause-and-effect relationships between geological processes and the cycling of Earth's materials. This activity provides a formal assessment opportunity for Performance Expectation MS-ESS2-1.	MS-ESS2.A MS-ESS2.C	Developing and Using Models Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Cause and Effect Scale, Proportion, and Quantity Systems and System Models Patterns Energy and Matter Stability and Change Structure and Function Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	ELA/Literacy: SL.8.1

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
16. **Reading: Rocks as a Resource** Students learn about the geological processes that result in the formation of three different natural resources. They connect those processes to maps showing the uneven distribution of these natural resources to make inferences about the past geological processes in those locations. This activity provides a formal assessment opportunity for Performance Expectation MS-ESS3-1, with a focus on mineral and energy resources.	MS-ESS2.A MS-ESS3.A	Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect Scale, Proportion, and Quantity Stability and Change Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems Connections to Nature of Science: Science Addresses Questions about the Natural and Material World	ELA/Literacy: RST.6-8.2 RST.6-8.7 WHST.6-8.1

GEOLOGICAL PROCESSES (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
17. **Investigation: Enough Resources for All** Students continue to learn about the limited nature of some natural resources due to the geological processes that create them. In this activity, they model aquifer inputs and outputs, and monitor water levels in aquifers over time. Students then *construct an explanation* of why aquifers are a limited but renewable resource. This activity provides a formal assessment opportunity for Performance Expectation MS-ESS3-1, with a focus on groundwater resources.	MS-ESS3.A	Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns Cause and Effect Systems and System Models Structure and Function Stability and Change Connections to Engineering, Technology, and Application of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Connections to Nature of Science: Science Addresses Questions about the Natural and Material World Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems	ELA/Literacy: RST.6-8.7 SL.8.1
18. **Talking It Over: Evaluating Site Risk** Students *analyze and interpret data* about four possible nuclear waste disposal sites from maps showing information such as natural hazard risk, location of natural resources, and human population density in the continental United States. Students are given the opportunity to apply their findings as they make a decision about which site should be studied further. Using evidence, they evaluate the risks and trade-offs of storing nuclear waste at each site. Students create connections between scientific knowledge and society by making a recommendation about which site should be considered for the long-term storage of nuclear waste. This activity provides a formal assessment opportunity for Performance Expectation MS-ESS3-2.	MS-ESS3.A MS-ESS3.B	Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Engaging in Argument from Evidence	Patterns Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World Connections to the Nature of Science: Science Addresses Questions about the Natural and Material World	ELA/Literacy: WHST.6-8.2

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES

GEOLOGICAL PROCESSES

Unit Issue: How natural hazards associated with geological processes have implications for the storage of nuclear waste.

Anchoring Phenomenon: The Earth's surface changes over time. Examples explored include the role of water in changing earth's surface, the frequency, locations, and effects of earthquakes and volcanoes and their associated natural hazards, and the uneven distribution of natural resources on earth. Students generate and answer questions such as: How and why does Earth's surface change? Why are some places much more likely than others to have earthquakes or volcanoes? What happens where Earth's plates meet? How do geologic processes affect where resources are found?

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Nuclear waste must be protected from natural hazards.	Where should deep underground sites for storing nuclear waste be developed in the United States?	What factors must be considered when deciding where to store nuclear waste? (Activity 1) How can we use evidence to decide where to store nuclear waste? (Activity 18)	1, (18)	MS-ESS3-2	Radioactive nuclear waste must be stored in ways that protect people from its harmful effects and prevent it from leaking into the air and water in the environment. One way to do this is to store the waste deep underground. Considerations that must be addressed in deciding on a site to store nuclear waste include active geological processes and associated natural hazards in the area, the distribution of valuable natural resources in the area, as well as proximity to large human populations.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Moving water can cause gradual and rapid changes on and below Earth's surface.	How does water move above and below Earth's surface, and how does it affect the land as it moves?	How does water interact with earth materials? (Activity 2) How can a natural hazard create challenges for storing nuclear waste? (Activity 3)	2, 3	MS-ESS2-1 MS-ESS2-2 MS-ESS3-1 MS-ESS3-2	If nuclear waste should be stored deep underground, why should it be stored in areas with little rainfall? Water that falls and flows on the surface can gradually travel deep underground through the soil into the rock layers below Earth's surface. This water can travel several miles underground through permeable rock layers, but it is slowed or stopped by impermeable layers. Underground water-bearing earth materials are called aquifers. People can remove water from aquifers to use as a natural resource for a variety of human activities; therefore, aquifers need to be protected from contamination. What natural hazards can rainfall cause? On Earth's surface, rainfall can cause rapid changes to the shape of the land during a landslide. Some areas with high amounts of rainfall are more susceptible to landslides due to the properties of the earth materials (rock) that make up the area. This means that some areas have a high likelihood of failure when rainwater flows down a slope. Landslides can cause a variety of natural hazards that can be mitigated through the use of technology and engineering.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Earthquakes and volcanic eruptions (and their related hazards) do not happen everywhere on Earth.	Why do some locations have earthquakes and volcanoes, and others do not?	What natural hazards are caused by earthquakes and volcanic eruptions? (Activity 4)	4, 5, 6, 7, 8, 9, 10, 11	MS-ESS2-1 MS-ESS2-2 MS-ESS2-3 MS-ESS3-2	What other natural hazards should we be concerned about when deciding where to store nuclear waste? Earthquakes and volcanic activity can cause natural hazards that must be considered. Earthquakes can cause sudden, intense ground-shaking. Volcanic eruptions generate igneous rock through the melting and cooling of magma both above and below ground. The hazards associated with these geological processes pose significant risks to the storage of nuclear waste; however, some of these risks can be mitigated by monitoring and advancements in engineering. Why do some locations have earthquakes and volcanoes, and others do not?
		How can models help us understand what happens during a volcanic eruption? (Activity 5)			
		What patterns can we see when examining the locations of earthquakes and volcanoes? (Activity 6)			
		How can GPS data help us understand Earth's surface? (Activity 7)			
		What is beneath Earth's surface? (Activity 8)			

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Earthquakes and volcanic eruptions (and their related hazards) do not happen everywhere on Earth.	Why do some locations have earthquakes and volcanoes, and others do not?	How can models help us understand earthquakes? (Activity 9)	4, 5, 6, 7, 8, 9, 10, 11	MS-ESS2-1 MS-ESS2-2 MS-ESS2-3 MS-ESS3-2	Earthquakes and volcanoes do not happen everywhere on Earth's surface. Earthquakes and volcanoes appear in patterns where plates meet. At these boundaries, Earth's plates are slowly colliding or spreading apart, and these plate motions cause earthquakes and volcanoes. Earthquakes also occur at plate boundaries where Earth's plates are sliding past each other. GPS is used to measure plate movement and direction, as well as monitor movement in areas where earthquakes and volcanoes happen. Evidence from earthquakes and volcanoes is used to understand the interior structure of Earth. Earth's internal energy drives the interactions at plate boundaries. Interactions between plates at boundaries cause the formation of mountain ranges and volcanoes, and cause earthquakes.
		What happens where Earth's plates meet? (Activity 10)			
		How can our understanding of geological processes at plate boundaries allow us to predict and prepare for natural hazards? (Activity 11)			

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
The edges of South America and Africa appear as though they could fit together.	Have Earth's plates moved in the past?	What evidence can we use to help us understand the movement of Earth's plates over time? (Activity 12)	12, 13, 14	MS-ESS2-1 MS-ESS2-2 MS-ESS2-3 MS-ESS3-2	Evidence from fossils and rocks, continental plates, and sea floor structures supports the theory that the plates have moved slowly over great distances in the past. Slow movement of the plates has resulted in large-scale changes to Earth's surface over time, such as the movement of the continents, the generation of new sea floor at ocean ridges, and the destruction of old sea floor at trenches. What makes Earth's plates move? Scientists think the movement of the plates is driven by gravity and energy in Earth's interior.
		How did Wegener's idea of continental drift lead to the theory of plate tectonics? (Activity 13)			
		What drives plate motion? (Activity 14)			

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Natural resources are distributed unevenly.	Why are natural resources found in different places around Earth?	How do rocks form? (Activity 15) How do geological processes affect where we find rock and mineral resources? (Activity 16) How can monitoring natural resources help guide decisions about their use? (Activity 17)	15, 16, 17	MS-ESS2-1 MS-ESS3-1	In addition to considering geological processes and related hazards in deciding where to store nuclear waste, decision-makers also must consider the availability of valuable natural resources at a potential storage site. Natural resources are formed by geological processes that constantly recycle earth materials to form new rock and may also result in the formation of valuable natural resources, such as metal ores. Natural resources are generated in areas where these geological processes are happening or have happened in the past, thus resulting in their uneven distribution. The supply of natural resources may be limited based on how quickly or slowly the associated geological process that forms them happens. As such, the use of natural resources must be monitored to minimize depletion.

PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

GEOLOGICAL PROCESSES (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	PE	Storyline
Nuclear waste must be protected from natural hazards.	Where should deep underground sites for storing nuclear waste be developed in the United States?	What factors must be considered when deciding where to store nuclear waste? (Activity 1)	(1), 18	MS-ESS3-2	Radioactive nuclear waste must be stored in ways that protect people from its harmful effects and prevent it from leaking into the air and water in the environment. One way to do this is to store the waste deep underground. Considerations that must be addressed in deciding on a site to store nuclear waste include the geological processes that happen in the area and the risk of associated natural hazards, the distribution of valuable natural resources in the area, as well as proximity to large human populations.
		How can we use evidence to decide where to store nuclear waste? (Activity 18)			

NGSS CORRELATIONS

GEOLOGICAL PROCESSES

Crosscutting Concepts		Activity number
Cause and Effect	Cause and effect relationships may be used to predict phenomena in natural or designed systems.	3, 4, 5, 9, 10, 11, 14, 15, 16, 17
Energy and Matter	Within a natural system, the transfer of energy drives the motion and/or cycling of matter.	9, 14, 15
	The transfer of energy can be tracked as energy flows through a designed or natural system.	14, 15
Patterns	Patterns can be used to identify cause and effect relationships.	13, 14, 17
	Graphs, charts, and images can be used to identify patterns in data.	1, 6, 7, 8, 10, 12, 16, 17, 18
	Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.	7, 13, 14, 17
Scale, Proportion, and Quantity	Phenomena that can be observed at one scale may not be observable at another scale.	7, 14, 16
	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	3, 5, 7, 8, 9, 10, 12, 14, 15
	Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.	7, 12, 13
Stability and Change	Small changes in one part of a system might cause large changes in another part.	9, 14
	Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.	3, 10, 11, 12, 13, 14, 15, 16, 17, 18
	Stability might be disturbed either by sudden events or gradual changes that accumulate over time.	3, 7, 9, 10, 11, 12, 13, 15
Structure and Function	Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.	2, 8, 14, 17
	Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	15

Crosscutting Concepts		Activity number
Systems and System Models	Systems may interact with other systems and be a part of larger complex systems.	6, 9, 15, 17
	Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.	2, 3, 5, 9, 10, 14, 15, 17
Connections to Engineering, Technology, and Applications of Science	Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.	7
	The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time.	4, 7, 18
	All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.	1, 16, 17
	Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.	7, 8
Connections to the Nature of Science	Scientists and engineers are guided by habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.	12, 13, 14
	Science assumes that objects and events in natural systems occur in consistent patterns and are understandable through measurement and observation.	6, 8, 12, 13, 14, 15, 16
	Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.	1, 16, 17, 18
	Advances in technology influence the progress of science, and science has influenced advanced in technology.	8
Science and Engineering Practices		**Activity number**
Analyzing and Interpreting Data	Analyze and interpret data to determine similarities and differences in findings.	2, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17, 18
	Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	8
	Analyze and interpret data to provide evidence for phenomena.	1, 6, 7, 9, 12, 13, 14, 15, 16, 17

Science and Engineering Practices		Activity number
Asking Questions and Defining Problems	Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	6, 9
	Ask questions to identify and clarify evidence of an argument.	1
Constructing Explanations and Designing Solutions	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.	3, 4, 5, 7, 10, 12, 13, 14, 15, 16, 17, 18
	Construct an explanation that includes qualitative or quantitative relationships between variables that predict or describe phenomena.	14
	Apply scientific ideas to construct an explanation for real world phenomena, examples, or events.	12, 13, 14, 15, 16, 17
Developing and Using Models	Develop and use a model to predict and/or describe phenomena.	2, 3, 5, 8, 9, 10, 14, 15, 16, 17, 18
	Develop a model to describe unobservable mechanisms.	2, 8, 15
Engaging in Argument from Evidence	Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	4,11
	Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.	12
	Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.	18
Obtaining, Evaluating, and Communicating Information	Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	4, 13, 16
	Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts.	1

Science and Engineering Practices		Activity number
Planning and Carrying Out Investigations	Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	9
	Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	2, 5, 10, 14, 17
	Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	9
Using Mathematics and Computational Thinking	Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.	8
	Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends.	6
Connections to the Nature of Science	Scientific knowledge is based on logical and conceptual connections between evidence and explanations.	12, 13, 14, 15, 17
	Science findings are frequently revised and/or reinterpreted based on new evidence.	8, 13, 14
Disciplinary Core Ideas		**Activity number**
The History of Planet Earth (ESS1.C)	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.	12
	Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.	10, 11, 13, 14
Earth's Materials and Systems (ESS2.A)	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.	5, 8, 9, 10, 11, 13, 14, 15, 16
	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.	3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16
Plate Tectonics and Large-Scale System Interactions (ESS2.B)	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.	10, 12, 13, 14

Disciplinary Core Ideas		Activity number
The Roles of Water in Earth's Surface Processes (ESS2.C)	Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.	2
	Water's movements—both on the land and underground— cause weathering and erosion, which change the land's surface features and create underground formations.	3, 15
Natural Resources (ESS3.A)	Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.	2, 16, 17, 18
Natural Hazards (ESS3.B)	Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	1, 3, 4, 6, 7, 18
Performance Expectations		**Activity number**
Earth's Systems (ESS2)	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. (MS-ESS2-1)	15
	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (MS-ESS2-2)	13
	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. (MS-ESS2-3)	14
Earth and Human Activity (ESS3)	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. (MS-ESS3-1)	16, 17
	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. (MS-ESS3-2)	18

COMMON CORE STATE STANDARDS: CONNECTIONS AND CORRELATIONS

GEOLOGICAL PROCESSES

Making Connections in ELA

As with all SEPUP instructional materials, this unit introduces multiple opportunities for students to engage in a range of ELA practices and skills that are important grade-specific goals of the common core state standards and are also essential to the sensemaking students are doing throughout the unit. Specifically, in activity 1, students explore the issue of nuclear waste storage by first reading background information and interpreting maps (RST.6-8.1). Throughout the unit (as in activities 2, 5 and 9), students follow multi-step procedures (RST.6-8.3) to complete hands-on investigations that support sensemaking about how geological processes such as earthquakes and volcanoes underlie the movement of Earth's plates. Students read about how these processes act as natural hazards to human populations in a reading in activity 4 and connect these ideas to the initial problem of nuclear waste storage (RST.6-8.2; WHST.6-8.9). In activity 7, students work in groups to analyze and connect GPS data with plate movements, and then present their findings for a class discussion (SL.8.4; SL.8.1). As the unit progresses, students develop an in-depth understanding of lithospheric plates and earth's interior by engaging in a reading in activity 8 (RST.6-8.4). Students continue to connect their understanding of plates to natural hazards, and use this information to construct an argument either for or against storing nuclear waste deep underground near plate boundaries (WHST.6-8.1). Towards the end of the unit, in activity 17, students learn about limited natural resources (and connect it with geological processes) by creating a model of an aquifer. This helps them consider groundwater supplies, and implications for limited water resources on earth (RST.6-8.7). The unit culminates in activity 18 where students consider a few different sites for storing nuclear waste, identify trade-offs, and ultimately create an explanation based on scientific evidence for the storage location site that they choose (WHST.6-8.2). In addition, Appendix E: Literacy Strategies in the Student Book contains optional resources to support reading, writing and oral communication.

Common Core State Standards – English Language Arts		Activity number
Reading in Science and Technical Subjects (RST)	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (RST.6-8.1)	1, 4
	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (RST.6-8.2)	4, 11, 13, 14, 16
	Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks. (RST.6-8.3)	2, 5, 8, 9
	Determine the meaning of symbols, Key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics. (RST.6-8.4)	8
	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). (RST.6-8.7)	16, 17

Common Core State Standards – English Language Arts		Activity number
Speaking and Listening (SL)	Engage effectively in a range of collaborative discussions (e.g., one-on-one, in groups, teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (SL.8.1)	6. 7, 10, 12, 15, 17
	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound and valid reasoning, and well-chosen details: use appropriate eye contact, adequate volume, and clear pronunciation. (SL.8.4)	7
Writing in History/ Social Studies, Science, and Technological Subjects (WHST)	Write arguments focused on discipline-specific content. (WHST.6-8.1)	11, 12, 16
	Write informative/explanatory texts to examine and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (WHST.6-8.2)	18
	Draw evidence from informational texts to support analysis, reflection, and research. (WHST.6-8.9)	4

Making Connections in Mathematics

This unit introduces multiple opportunities for students to engage in math practices and skills that are important grade-specific goals of the common core state standards and are also essential to the sensemaking students are doing throughout the unit. In activity 1, students analyze and interpret data from maps showing human population density and locations of operating nuclear reactors in the United States (MP.2). Further along in the unit, in activity 7, students analyze GPS data to visualize ground motion. They connect this information to locations of natural hazards, and why nuclear waste should or should not be stored in those areas (MP.4; 6.NS.C.5). In activity 12, students use a world puzzle to consider how land masses fit together and how the positions of continents have changed over time. In doing so, they connect back to the nuclear waste storage issue by comparing the amount of time nuclear waste remains dangerous, to the time it took for Pangea to break apart. Students use fractions or ratios to compare these time periods (6.RP.A.1; 7.RP.A.2).

Common Core State Standards – Mathematics		Activity number
Mathematical Practice (MP)	Reason abstractly and quantitatively. (MP.2)	1, 14
	Model with mathematics. (MP.4)	7
The Number System (NS)	Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/ below sea level, credits/debits, positive/negative electrical charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of zero in each situation. (6.NS.C.5)	7
Ratios and Proportional Reasoning (RP)	Understand the concept of a ratio, and use ratio language to describe a ratio between two quantities. (6.RP.A.1)	8, 12
	Recognize and represent proportional relationships between quantities. (7.RP.A.2)	12