# UNIT OVERVIEW

## 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.

Listed below is a summary of the activities in this unit. Note that the total teaching time is listed as 26–32 periods of approximately 45–50 minutes (approximately 6–7 weeks). If there is insufficient time to complete the unit, consider conducting Activities 5 and/or 9 as class or teacher demonstrations.

| Activity Description | Topics | Advance Preparation | Assessment | Teaching Periods |
|---|---|---|---|---|
| 1. **Talking It Over: Storing Nuclear Waste**<br>Students read about what nuclear waste is, how it affects people, and how it should be stored safely. Then, they review maps that show population density by county and the locations of operating nuclear reactors in the contiguous United States to consider the social concerns related to deciding on a central location to store the country's nuclear waste. Students use what they have learned from the reading and the map analysis to identify the risks and challenges in selecting a long-term storage site for nuclear waste. | Nuclear waste storage, risk analysis, evidence and trade-offs, patterns<br>SENSEMAKING | Prepare Student Sheet. | E&T A1 | 1–2 |
| 2. **Investigation: Investigating Groundwater**<br>Students investigate how water interacts with earth materials. In the activity, they observe how water flows through tubes filled with sand and clay. Students discuss the properties of the earth materials that affected whether water could flow through them. Students relate these properties to rock made primarily of the earth materials they investigated. Using a diagram, they learn how water flows underground to form aquifers. Students consider how the location of aquifers in the United States might influence their decisions about where to store nuclear waste. | Groundwater, aquifer, aquitard<br>LITERACY<br>SENSEMAKING | Fill enough plastic cups with sand and enough plastic cups with clay for each group of four students; arrange for a supply of water; prepare Student Sheet. | ODA Proc. | 2 |

## GEOLOGICAL PROCESSES (continued)

| Activity Description | Topics | Advance Preparation | Assessment | Teaching Periods |
|---|---|---|---|---|
| 3. **View and Reflect: Modeling Landslides** Students share their prior knowledge about natural hazards, particularly landslides. They observe and discuss images of four major landslides that occurred in the continental United States. Students use an Anticipation Guide to prepare for viewing a video. This video documents a team of scientists using a model to better understand how and why landslides happen. Students return to the Anticipation Guide after viewing the video and discuss what they learned about how scientists use models. Students relate landslide risk to the issue of nuclear waste storage. | Natural hazard; landslide; scientific model; scale, proportion, and quantity<br>SENSEMAKING | Arrange Internet access to stream the video; prepare Student Sheet. | EXP QUICK CHECK A2 | 1–2 |
| 4. **Reading: Natural Hazards Caused by Earthquakes and Volcanoes** Students learn about the natural hazards caused by earthquakes and volcanic activity through reading about four real-world geological events. Students complete notes using the Directed Reading Table graphic organizer, and use what they've learned about different hazards associated with earthquakes and volcanic eruptions to again think about the issue of nuclear waste storage. | Natural hazard, earthquake, volcano, cause and effect<br>LITERACY<br>SENSEMAKING | Prepare Student Sheet. | ARG QUICK CHECK A1 | 1 |
| 5. **Modeling: Modeling Volcanic Eruptions** Students consider how volcanic eruptions form igneous rock as they model the effects of two different kinds of volcanic eruptions. | Volcano, systems and system models, lava, magma, igneous rock<br>LITERACY | Gather chemical splash goggles, paper towels and/or sponges; arrange for supply of water. | ODA Proc. | 1 |
| 6. **Investigation: Mapping Locations of Earthquakes and Volcanoes** Students use a data visualization program to analyze data and look for patterns related to the distribution and locations of earthquakes and volcanoes. | Earthquake, volcano, magnitude | Arrange Internet access, prepare Student Sheet. | AID A1 | 1 |
| 7. **Problem Solving: Observing Earth's Moving Surface** Students analyze and interpret GPS data that show movement of Earth's surface. | GPS, time-series data plot | Prepare Student Sheet. | AID A2, A3 | 2 |

## GEOLOGICAL PROCESSES (continued)

| Activity Description | Topics | Advance Preparation | Assessment | Teaching Periods |
|---|---|---|---|---|
| 8. **Reading: Beneath Earth's Surface** Students make predictions about what is inside Earth. Through a reading, they learn about how humans know about Earth's interior, its layers, and lithosphere (which is broken into plates that move). Finally, they use the information provided in the reading to make a scaled drawing of Earth's interior complete with labels of the name, depth, and state of each layer. | Structure of Earth, lithospheric plates<br>LITERACY<br>SENSEMAKING | Prepare Student Sheets. | MOD A4 | 2 |
| 9. **Modeling: Modeling Earthquakes** Students plan and carry out an investigation using an earthquake model. They simulate friction between lithospheric plates by using sandpaper and a wooden block. They slowly pull on rubber bands attached to the block. Eventually friction is overcome, and the elastic energy is transformed into kinetic energy as the block surges forward. Groups decide which variables to change as they use the model to investigate factors that affect earthquakes. | Energy transfer, experimental variables, friction, models, earthquake<br>SENSEMAKING | | PCI Proc. | 2 |
| 10. **Computer Simulation: Plate Boundaries** Students use a computer simulation to investigate what happens at plate boundaries, where plates move apart, collide, or slide past each other. Students investigate the rate of changes on Earth due to plate motion as they observe the simulation as it models different time periods, from 10 years to 20 million years. They then compare the similarities and differences in the geological processes that occur at three types of plate boundaries. | Convergent, divergent, and transform plate boundaries; mantle; stability and change | Arrange Internet access; prepare Student Sheets. | AID A3 | 2 |
| 11. **Reading: Understanding Plate Boundaries** Students read an article about the three types of plate boundaries and the changes they cause to Earth's surface. They connect their understanding of the geological processes that happen at plate boundaries to the nuclear waste issue. | Plate boundaries, mid-ocean ridge, subduction, trench, cause and effect<br>LITERACY<br>SENSEMAKING | Prepare Student Sheet. | ARG A3 | 1–2 |

## GEOLOGICAL PROCESSES (continued)

| Activity Description | Topics | Advance Preparation | Assessment | Teaching Periods |
|---|---|---|---|---|
| 12. **Investigation: The Continent Puzzle** Students use a World Puzzle that has both rock and fossil evidence, as well as the shapes of the continents. They work to rearrange the landmasses so the shapes fit together and the pieces of evidence line up. They then theorize that the position of the continents has changed over time. They compare their World Puzzle to three past landmass arrangements and recognize that their puzzle matches Pangea. | Pangea, stability and change<br>SENSEMAKING | Prepare Student Sheet. | ARG A3 | 1 |
| 13. **View and Reflect: The Theory of Plate Tectonics** Students watch two video segments on the history of the development of the modern theory of plate tectonics, beginning with Wegener's idea of continental drift. They use Student Sheet 13.1 to review key ideas presented in the videos. | Continental drift, plate tectonics<br>LITERACY | Arrange Internet access to stream the video; prepare Student Sheet. | EXP A3 (Assessment of PE MS-ESS2-2) | 1–2 |
| 14. **Laboratory: What Makes the Plates Move?** Students learn about the forces that drive tectonic plate motion through the use of two models. In the first model, students learn about the conditions necessary to form a convection current. Students then model the force of gravity on subducting plates as well as on mid-ocean ridges. | Convection, slab pull, gravity, density<br>SENSEMAKING | Arrange access to warm and cold water. | AID A4 (Assessment of PE MS-ESS2-3) | 2 |
| 15. **Investigation: The Rock Cycle** Students learn about how the changes on Earth's surface lead to the formation of different kinds of rock. They participate in a rock cycle game, which models the ways different rocks are formed. They then synthesize their experiences from the game to develop a model of the rock cycle, with arrows between different kinds of rock explaining how they can be transformed. | Igneous rock, metamorphic rock, sedimentary rock, rock cycle, erosion, cause and effect<br>SENSEMAKING | Prepare Student Sheets. | MOD A1 (Assessment of PE MS-ESS2-1) | 1–2 |

## GEOLOGICAL PROCESSES (continued)

| Activity Description | Topics | Advance Preparation | Assessment | Teaching Periods |
|---|---|---|---|---|
| 16. **Reading: Rocks as a Resource** Students read about the geological processes that led to the creation of three natural resources. They learn that many natural resources only form in specific geological conditions and take long periods of time to form, making them scarce and nonrenewable. Finally, students consider the advantages and disadvantages of storing nuclear waste near natural resources. | Nonrenewable resources, uneven distribution of resources<br>LITERACY | Prepare Student Sheet. | EXP A4 (Assessment of PE MS-ESS3-1: Part 1) | 1–2 |
| 17. **Investigation: Enough Resources for All** Students use a model aquifer to learn about aquifer inputs and outputs. They connect the use and replenishment of aquifers to humans' reliance on groundwater. Students monitor the water levels in four aquifers over time by constructing a graph for each. They then use what they've learned about aquifer inputs and outputs to interpret the graph, look for trends, and come up with a possible explanation for the changes over time to the groundwater level in the aquifers. | Aquifer, renewable resources, systems and system models<br>SENSEMAKING | Prepare Student Sheets. | EXP A4 (Assessment of PE MS-ESS3-1: Part 2) | 2 |
| 18. **Talking It Over: Evaluating Site Risk** Students gather and analyze data about four proposed sites in the continental United States in which to store nuclear waste. Students use these data as evidence to support their decisions about which of the proposed sites should be studied further to determine if it is suitable for long-term storage of nuclear waste. Students consider the trade-offs of their decisions. | Evidence, nuclear waste, risk, trade-offs<br>LITERACY<br>SENSEMAKING | Prepare Student Sheets. | AID PROC. E&T A3 (Assessment of PE MS-ESS3-2) | 2 |