PHENOMENA, DRIVING QUESTIONS AND STORYLINE

GEOLOGICAL PROCESSES

Phenomenon: Earth's surface changes in different ways and over different time scales.

This unit explores concepts and issues related to the question: How and why does Earth's surface change?

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
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 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.
		How can we use evidence to decide where to store nuclear waste? (Activity 18)			

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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)	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.
		How can a natural hazard create challenges for storing nuclear waste? (Activity 3)			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.

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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 to understand Earth's surface? (Activity 7)			
		What is beneath Earth's surface? (Activity 8)			

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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) What happens where Earth's plates meet? (Activity 10) How can our under-standing of geological processes at plate boundaries allow us to predict and prepare for natural hazards? (Activity 11)	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.

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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)			

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Natural resources are distributed unevenly.	Why are natural resources found in different places around Earth?	How do rocks form? (Activity 15)	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.
		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)			

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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 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.