Earth Science - Unit 2 - Earth as a System

Unit Focus

In this unit, students will uncover the geologic cause and effect of some of the natural phenomenon that takes place on our planet. Students will analyze the interdependence of the fours spheres of Earth and the biogeochemical cycles that are integral to Earth's system and examine evidence to support the earth's composition, structure, and movements. Through the application of the concepts of density, force, heat, and heat transfer, students will be able to understand the forces that cause the movement of tectonic plates and how this movement causes events such as earthquakes, tsunamis, and volcanic eruptions. Additionally, students will learn how the tools and techniques in geology, along with scientific observation and reasoning, can be used to explain earth's geologic features.

Stage 1: Desired Results - Key Understandings

Standard(s)

Next Generation Science

High School Earth and Space Sciences: 9 - 12

- Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. *HS-ESS2-1*
- Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. *HS-ESS2-2*
- Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. *HS-ESS2-3*
- Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. *HS-ESS2-4*
- Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. *HS-ESS3-5*

High School Physical Sciences: 9 - 12

- Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system

Transfer

T1 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.
T2 Use the scientific process to generate evidence that addresses the original questions.

Meaning

Understanding(s)	Essential Question(s)
U1 Forces at work in the Earth's systems drive heat transfer. **U2** Scientists use techniques to recover evidence that supports the Theory of Plate Tectonics. **U3** Plate movements have caused the positions of Earth's landmasses to shift over time. The shapes of the landmasses have also changed due to constructive and destructive forces. **U4** The Earth's systems continually interact to create the global environment. **U5** Processes within the geosphere are the basis for the feedback loops that influence our global system.	**Q1** How do internal and external forces influence Earth's systems? **Q2** How can phenomena caused by the interaction of the Earth's spheres be explained using scientific evidence? **Q3** How do feedback loops influence the global environment? **Q4** How does the shape of the ocean basin influence the environment? **Q5** How do the spheres of Earth interact to allow Earth to function as a sustainable system?

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
K1 The formation of the Earth is the original source of heat in the geosphere. Over time, the heat is being lost to space, causing internal cooling.	**S1** Apply scientific reasoning to interpret data that supports the idea that Earth rotates and influences ocean currents.

Stage 1: Desired Results - Key Understandings

results in a more uniform energy distribution among the components in the system (second law of thermodynamics). *HS-PS3-4*

Next Generation Science Standards (DCI)
Science: 9

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. *ESS2.9.A1*
- 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. *ESS2.9.A2*
- 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. *ESS2.9.A3*
- 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. *ESS2.9.B1*
- 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. *ESS2.9.B2*
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K2 The Earth's four spheres are the geosphere, hydrosphere, biosphere and atmosphere.
K3 Mantle convection, ridge push, and slab pull are hypothetical models to explain plate movements.
K4 To track the movements and composition of the continental crust, scientists use techniques such as seismic wave sampling, fossil evidence, radioactive dating, topography, and patterns in the distribution of volcanoes and earthquakes.
K5 Convergent boundaries can be classified as subduction boundaries or collision boundaries.
K6 Plates move apart at divergent boundaries, toward each other at convergent boundaries, and past each other at transform boundaries.
K7 To determine the shape and composition of the ocean floor, scientists use techniques such as echo sounding, sediment sampling, and satellite observation
K8 The ocean basin's topography is not static, and varies widely which includes features such as abyssal plains and hills, deep ocean trenches, underwater mountain ranges, and mid-ocean ridges.
K9 Earth formed from a cloud of gas and debris into a multilayered sphere orbiting around a single star.
K10 The geosphere is composed of three main layers; core, mantle, crust.
K11 The geosphere temperature is cooling over time due to heat transfer out of the interior.
K12 The theory of plate tectonics explains why volcanoes and earthquakes tend to occur in concentrated belts and why the ages of rocks on the ocean floor show a distinctive pattern.
K13 Ocean feedback loops include ocean currents, and movement of heat toward the poles.
K14 The mantle is made out of hard rocky plates called the lithosphere that float on the asthenosphere, which is in motion over geologic time and is responsible for the movement of the plates.
K15 The Gulf Stream is a current that transports heat north and is part of the North Atlantic gyre.

S2 Use data and scientific evidence and reasoning to support plans for a potential hazardous natural event in the future.
S3 Using scientific data and evidence, explain the role of heat transfer in the creation of natural phenomena.

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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. *ESS2.9.B3* • 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. *ESS2.9.C1* **Madison Public Schools Profile of a Graduate** *Critical Thinking* • Analyzing: Examining information/data/evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2) *Collaboration/Communication* • Product Creation: Effectively use a medium to communicate important information. (POG.3.2)	**K16** Continental and Oceanic rock vary in density which contributes to variation in buoyancy forces, influencing plate movements and subduction zones. **K17** Natural factors, such as volcanic eruptions, the greenhouse effect, ocean currents, etc. influence global climate. **K18** Anthropogenic means caused by human influence. **K19** Anthropogenic changes, such as combustion of fossil fuels, can alter the natural feedback loop that maintains Earth's climate. **K20** Vocabulary: geology, inner core, outer core, mantle, crust, lithosphere, asthenosphere, plate tectonics, continental drift, mid-ocean ridge, divergent boundary, rift valley, rift, convergent boundary, subduction boundary, deep-sea trench, collision boundary, transform boundary, mantle convection, ridge push, slab pull, Pangaea, core sampling, continental shelf, continental slope, continental rise, active margin, passive margin, abyssal plain, island arcs, seamount, gyre, buoyancy, Gulf Stream	