Plate Tectonics

High School Earth & Space Science

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Idaho State Science Performance Standards:

- **ESS1-HS-5.** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
- **ESS1-HS-6.** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
- **ESS2-HS-1.** 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.
- **ESS2-HS-7.** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Science & Engineering Practices:

- Analyzing and interpreting data
- Constructing explanations and designing solutions
- Developing and using models
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Crosscutting Concepts:

- Patterns
- Cause and Effect
- Systems and System Models
- Energy and Matter
- Stability and Change

Idaho Math & ELA Standards:

ELA/Literacy

- **RST.11-12.7.** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **RST.11-12.9.** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
- **SL.11-12.4.** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- **WHST.11-12.2.**Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.11-12.7.** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **WHST.11-12.9.** Draw evidence from informational texts to support analysis, reflection, and research.

Mathematics

- **HSA.CED.A.1.** Create equations and inequalities in one variable and use them to solve problems.
- **HSF-IF.C.7.** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- **HSS-IC.B.6.** Evaluate reports based on data.
- **HSS-ID.B.6.** Represent data on two quantitative variables on a scatter plot, and describe how those variables are related.

Essential Question:

How does our geologic past inform our future?

Guiding Questions:

What questions will constantly focus the students on the Big ideas/Critical Question within the unit in student language?

- How do the ages of continental and oceanic crusts compare?
- What evidence exists supporting the theory of plate tectonics?
- How does plate movement contribute to the surface features that we observe today?
- What causes plate movement?
- How can we predict future movement of tectonic plates?

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Misconceptions/Evolving Conceptions:

What might students commonly misunderstand about the subject? How will I directly address these?

- Only continents move
    - This was Wegener's original hypothesis. Continents can be a part of much larger plates consisting of both continental and oceanic crust.
- The edge of a continent is the same thing as a plate boundary.
    - Continents can exist on separate plates that move in different directions and be a part of much larger plates consisting of both continental and oceanic crust. For example, there is no active plate margin on the east coast of North America.
- Present oceans only began as Pangea broke apart.
    - This is tied to the general idea that Pangea was the original continent at the Earth's start
    - Wegner focused on the most recent supercontinent. There have been many supercontinents over Earth's geologic history.
- A plate boundary type is the same thing as a plate. For example, a plate has to be divergent or convergent
    - A plate can have many different types of boundaries. For example, the Pacific plate is converging with the Indo-Australian Plate, but diverging from the Nazca plate. A transform boundary exists between the Pacific and North American Plate.

Scaffold of Activities:

What is your lesson sequence you will use to get students to the culminating project?

1. Frontloading/Introduction
    a. Mind Map
        i. Write the question "Why are the continents where they are?" on the board.
        ii. Have each table group create a mind map by writing their initial thoughts.
        iii. Students should color code their maps: red = further questions, green = personal connections
        iv. Tape their maps to their tables and encourage students to add to it as more questions and connections emerge throughout the unit.
2. **Pangaea Puzzle**
    a. Introduction to Continental Drift; development of a theory
3. **Seafloor Ages: Data and Map Analysis**
    a. Age patterns exist on the ocean floor.
    b. How does the location of young or old seafloor contribute to more complicated patterns?
4. **Seafloor Polarity: Data and Graph** (From Earthref.org)
    a. Define Geomagnetic Reversals.
    b. In what way do GMR's support the theory of plate tectonics?

5. **Hawaiian Island Movement Calculations and Graphs** - (From Hofstra University, MiSP Project)
    a. How fast are the continents moving?
    b. What direction are they moving?
    c. Can we predict future movement?
6. **Seafloor Heat Dissipation Graph**
    a. Define and describe convective flow
7. **Benioff Zone Data and Graph**
    a. What happens to the seafloor as we move away from a spreading center?
    b. How does density play a role in plate tectonics?
    c. Boundaries exist between plates and can be classified based on their interactions.
8. **Earthquake and Volcano Map and Analysis**
    a. Where do plate boundaries exist?
    b. What types of features do we observe at plate boundaries?

Ongoing Formative Assessments:

- Class Discussions (Pangaea Puzzle)
- Activity Responses (Seafloor Ages and Polarity)
- Map Models (Earthquake Map and Benioff Zones)
- Data Sets and Graphs (Benioff Zones, Hawaiian Movement, Seafloor Polarity and Heat Dissipation)

Summative Assessment/Culminating Project:

- Students will create their own fictional Earth-like planet complete with continents, oceans, active tectonic margins, mountains, earthquakes, volcanoes, and other evidence of a dynamic system. The planet will have its own fictional geologic history that explains not only the changing surface but the evolution of any organisms that might live there. The planet will be presented as a Mercator Projection Map (rectangular map of a spherical planet).
- Create Your Own Planet Project
    - *This project can be introduced all at once or scaffolded with the smaller steps. For example, students can begin Step 1 after being introduced to the Pangaea Puzzle. While I had students naming plate boundaries in this step, it is not necessary until Step 2 in the project. This unit does not go over geologic time and evolution since these topics were covered earlier in the semester and in students' prerequisite biology class.*

Additional Helpful Resources:

- Exploring Earth Visualizations
- The Paleomap Project

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- Overview of Plate Tectonics (from Wikibooks)