THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Observing the Seafloor

What patterns and relationships do we find by observing the ages of rock on the seafloor?

GRADES 6–8

Earth & Space

VAN ANDEL EDUCATION INSTITUTE
VAEI.ORG

INQUIRY-BASED SCIENCE

Earth & Space

Observing the Seafloor

Grade Level/ Content	6–8/Earth and Space Science
Lesson Summary	This lesson is the follow-up lesson to Continents on the Move. In this lesson, students use an ocean floor map to identify patterns and trends in the ages of rock and geologic features on the seafloor. At the conclusion of this investigation, students are tasked with creating their initial model of the ocean floor.
Estimated Time	1, 45-minute class period
Materials	Isochronic Map, Ridge Map, Trench Map, Vis-à-Vis markers, Investigation Plan, journal
Secondary Resources	• Deepsea Challenge • Trench Image • Ridge Image • National Geographic Encyclopedia • JASON Digital Leaning Resources
NGSS Connection	**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.
Learning Objectives	• Students collect, analyze, and interpret data of the seafloor to identify patterns in the ages of rocks. • Students create a model representing the movement of rock at trenches and mid-ocean ridges.

What patterns and relationships do we find by observing the ages of rock on the seafloor?

Scientists estimate that nearly 95% of the ocean floor is still unexplored. It is easy to say that we actually know more about the surface of the Moon or Mars than the ocean floor. Well, it's how you define the term "explored." The Scripps Institute of Oceanography in San Diego has mapped 100% of the ocean floor to a maximum resolution of approximately 5km across using satellites. Radar cannot directly measure the ocean landscape, but can detect variations in the sea surface height. For example, where there are mid-ocean ridges, the satellites detect a "bump" in the sea surface. Alternatively, where there are trenches, the satellites detect a "dip" in the sea surface.

So, is the ocean still the final frontier? Well one thing is for certain, without our knowledge of the seafloor, the plate tectonic theory would not exist. In this investigation, students observe the ages of rocks on the ocean floor to identify patterns found at mid-ocean ridges and trenches. From this information, they create a model describing the movement of these rocks at each of these geological features.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Students will need the following materials:

- Isochronic Map (laminated is ideal)
- Ridge Map
- Trench Map
- Vis-à-Vis markers to use on laminated isochronic map
- Investigation Plan
- Journal

Part 2

INVESTIGATION FACILITATION

Question

Introduce investigation question.

What patterns and relationships do we find by observing the ages of rocks on the sea floor?

Personal Knowledge

Students capture what they already know about the seafloor, mid-ocean ridges, and trenches.

- Find out what students already know and questions they have about the seafloor, mid-ocean ridges, and trenches.
- Generate a class list. *(List may include: much of the sea floor is undiscovered, really interesting looking fish live on the seafloor, have humans ever explored the bottom of a trench?)*

DISCOURSE

Conduct a *Pass the Paper* with students working in pairs. One student writes "What I Know" at the top of their paper and the other student writes "What Questions I Have" at the top of another piece of paper. Each student responds to the prompt at the top of their paper. They pass their paper after a given time and add to their partner's list. Students continue to pass back and forth until the time is up. Have students share out their lists. The questions can also go on a *Question Wall* and be referred to during the investigation.

Secondary Knowledge

Students use resources to understand the terms trench and mid-ocean ridge.

Students need to have a basic understanding of a trench and a mid-ocean ridge before completing this investigation. Discuss with students (using readings, videos and/or images) what these terms mean. Their understanding should only focus on the physical features and not the processes that are occurring at each feature. The "how" should be left for after the investigation and follow-up investigations.

Continued

Trench: The deepest part of the ocean.
Mid-ocean ridge: Underwater mountain range.
National Geographic Encyclopedia

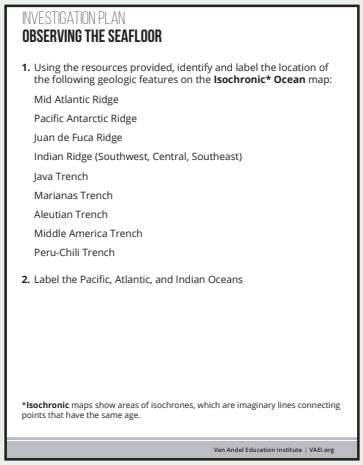
CURIOSITY

To promote curiosity, show students images and video clips from James Cameron's Deepsea Challenge. Let students know that in this investigation they will be discovering how deep sea trenches and mid-ocean ridges relate to the ages of rocks on the seafloor.

Investigation Plan

Students use the maps provided to collect data about the ocean floor.

- Have students work in teams of two. Review the maps provided as a class.
- Inform students that they will be making their observations on the Isochronic Ocean Map. This is a map that shows areas of isochrones, which are imaginary lines connecting points that have the same age.
- Using the Trench Map and Ridge Map, students will be identifying and labeling the location of various trenches and ridges on the Isochronic Ocean Map. They will also need to identify the Atlantic, Pacific, and Indian Oceans.



INVESTIGATION PLAN
OBSERVING THE SEAFLOOR

1. Using the resources provided, identify and label the location of the following geologic features on the **Isochronic* Ocean** map:
   - Mid Atlantic Ridge
   - Pacific Antarctic Ridge
   - Juan de Fuca Ridge
   - Indian Ridge (Southwest, Central, Southeast)
   - Java Trench
   - Marianas Trench
   - Aleutian Trench
   - Middle America Trench
   - Peru-Chili Trench
2. Label the Pacific, Atlantic, and Indian Oceans

***Isochronic** maps show areas of isochrones, which are imaginary lines connecting points that have the same age.

Van Andel Education Institute | VAEI.org

Investigation Plan

CRITICAL THINKING

Use the Fair Test checklist to help students think critically about the investigation plan. Help them understand that a good investigation plan must include a test that is repeatable, generates quality data, and minimizes error. The more critically students think about their investigation plan, the more confident they can be in their results.

Observation

Students record their observations on the isochronic map provided.

- Have students identify and label the ridges and trenches identified in their investigation plan on the isochronic map.
- Encourage students to write down any questions that bubble up in their journals as they are making their observations.

INTEGRITY AND PERSEVERANCE

Some of the map orientations may be a bit of a challenge for students to accurately record their information. Encourage students to use perseverance as they work through this investigation and integrity to ensure that information is drawn accurately.

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

Students make sense of their data by organizing it and representing it visually.

- Have students analyze their data. They may wish to use the Data Analysis prompt as a guide.
- Have students **evaluate** their data for trustworthiness. Ask students: *Are you confident in your data? Are you confident in your sources?*
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning.
    - Have students respond to the following:
        - » What patterns do you see?
        - » What do you notice about the age of rocks on the seafloor?
        - » How do the geologic features you identified relate to the ages of rocks?
- Have students join another group and compare their analyses. As a group, have the students decide on an interpretation of their analyzed data. They will **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.

DISCOURSE

If your students are new to the process, it may be helpful to have students share examples with a *Research in Progress*. After each step of data analysis, have a group or two share their progress.

Secondary Knowledge

Students use secondary sources to understand what accounts for the patterns in rock ages they identified.

Share videos, readings, and images about the geological processes that are occurring at trenches and mid-ocean ridges. Possible resources include:

USGS: Developing the Theory
National Geographic Encyclopedia
JASON Digital Leaning Resources
Discovery Education video (Login required to access Greatest Discoveries with Bill Nye: The Seafloor is Spreading)

From this information, students should learn that the youngest rocks are found at the center of the ocean floor at mid-ocean ridges, where new ocean crust is forming. The greater the distance from the ridges, the older the rocks. Students should also learn that the oldest rocks are found at the trenches where old ocean floor is being pushed back into the mantle. Students use this information in the reasoning portion of their investigation.

CURIOSITY

When curious people learn new information, they continue to ask questions and make connections. Support curiosity development by encouraging students to share their learning from secondary resources using a *Fact-Question-Connection* format. They should share one fact they learned, one question they still have, and one connection from what they learned to something they already know, something they are interested in, or something another classmate said.

Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the Explanation prompt as a guide. Have them write their explanation in their journal.
- Have students develop a **Claim** to answer the question: What patterns and relationships do we find by observing the ages of rocks on the seafloor?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

We claim that the youngest ocean floor rock is found at the center of the ocean floor along mid-ocean ridges and gets older the farther it is from the ridge. At trenches, ocean floor rock is younger the farther it gets from the trench.

Evidence

On the isochronic map, the center of the mid-ocean ridges was a dark red color, indicating younger rocks, 0-25 million years old. The colors changed on either side of the ridge from yellow (50 million years old) to green (80 million years old) to blue (170 million years old). We found that trenches we identified were located between a continental coast and the seafloor. Seafloor rocks tended to be younger farther out from the trench, the opposite pattern from the ridges.

Reasoning

Investigation: We followed the investigation plan carefully and we are very confident in our sources. During our data analysis, we identified patterns with another group to help strengthen our evidence.

Science: From our class discussions and videos, we learned that mid-ocean ridges are actually volcanic and new ocean floor is constantly being created there, pushing the old ocean floor away. This is called seafloor spreading. We also learned that old ocean floor is pushed back down under the crust into the mantle at trenches. The ages of rocks on the ocean floor helped provide some of the evidence scientists needed to support the seafloor spreading hypothesis.

- Once the explanation is written, have students discuss their results using a Present and Defend.

DISCOURSE

Have students conduct a Present and Defend to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning. If students are doing the same investigation plan, choose 1 or 2 groups to share.

Evaluation

Students reflect on the investigation.

- Ask students what surprised them.
- Ask students what questions they have as a result of this investigation.

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

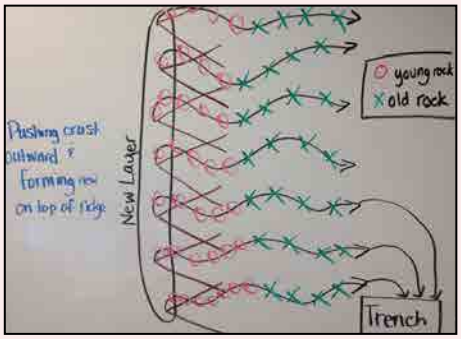
Application

Students demonstrate understanding by developing a model.

Have students develop a model explaining the patterns they observed. This can be done as a diagram, 3D representation, etc. Students will then share their model with the class.

Assessment

- Students provide an explanation (**claim, evidence,** and **reasoning**) identifying patterns in the ages of rock on the seafloor.
- Students develop and share a model explaining the patterns they observed.



Seafloor Model

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

nexgen inquiry®
Empowering Teachers. Engaging Students.

INVESTIGATION PLAN

OBSERVING THE SEAFLOOR

1. Using the resources provided, identify and label the location of the following geologic features on the **Isochronic* Ocean** map:

Mid Atlantic Ridge

Pacific Antarctic Ridge

Juan de Fuca Ridge

Indian Ridge (Southwest, Central, Southeast)

Java Trench

Marianas Trench

Aleutian Trench

Middle America Trench

Peru-Chili Trench

2. Label the Pacific, Atlantic, and Indian Oceans

***Isochronic** maps show areas of isochrones, which are imaginary lines connecting points that have the same age.