Introduction

Module goals

Students will understand key evidence for plate tectonics theory and will use this evidence to verify the theory. They will understand fundamental differences in plate boundaries and how they affect tectonics in those areas. Students will know that plate tectonics has been active for hundreds of millions of years and evidence of past activity is in the rock record.

Additionally, by examining historic hazards, world population and wealth, students will understand the relationship between *hazard* and *risk*. They will also be able to develop plans for reducing risk.

Learning objectives

Searching for evidence

In this unit, students will

- interpret patterns of seafloor topography, earthquakes, and volcanoes to predict the locations and types of plate boundaries;
- compare predicted plate boundaries to currently accepted boundaries and evaluate the differences; and
- use relative plate motion data to classify types of plate boundaries.

Exploring plate tectonics

In this unit, students will

- measure the spreading rate of ocean ridges;
- use evidence to show that plate motions have changed over time; and
- make predictions of how plates will change over time.

Overview of Exploring the Dynamic Earth

In this learning module, students explore the process that governs the large-scale structure of the Earth's surface, plate tectonics. The module consists of five individual units and can be divided into two broad topics: plate tectonics itself and the geologic hazards that arise from the process.

In the plate tectonics units (1 and 2), students examine evidence for plate tectonics and investigate the relationships between earthquakes, volcanoes, and plate boundaries using a Geographic Information System (GIS). They use this evidence to construct their own understanding of plate tectonics, how it has formed the Earth's surface, and changes it may trigger in the future. In the hazards units (3, 4, and 5), students apply what they have learned in the first two units to explore geologic hazards world-wide.

This module emphasizes three basic concepts:

- heat is a driving force for plate tectonics;
- present tectonic activity is a key to the past, and the past can be used to understand the future; and
- hazards become disasters when people are affected.

Exploring the Dynamic Earth units

The Exploring the Dynamic Earth units introduce students to the processes that shape the Earth and the implications of these processes on society:

- In Unit 1, **Searching for evidence**, students investigate patterns in the global distribution of earthquakes, volcanoes and topographic anomalies to discover the locations and properties of different types of tectonic boundaries.
- In Unit 2, **Exploring plate tectonics**, students explore patterns of seafloor age and calculate the rate of spreading in the Atlantic Ocean. They use their results to understand the history of opening the Atlantic basin and how spreading rates change over time. Next, they compare these rates to the Pacific Ocean to see that spreading rate is not globally uniform. Using plate motion vectors, students predict future trends of plate motion and calculate the time required for the Juan de Fuca plate to be completely subducted. They calculate seafloor spreading rates for the Hawaiian-Emperor chain using hotspot volcanism. Finally, they look at the motion of California along the San Andreas Fault and see that San Francisco and Los Angeles are slowly moving closer to each other.

Earthquake hazards

In this unit, students will

- explain the causes of deadly earthquakes;
- describe and explain the causes of the spatial and temporal distribution of deadly earthquakes through historical times;
- analyze risk factors for a country or region; and
- make predictions about the risk of earthquake hazards by using knowledge of a country's population density, gross domestic product, and historical seismicity.

Volcano hazards

In this unit, students will

- define VEI and give examples of hazards associated with eruptions of different VEIs;
- calculate the recurrence interval of eruptions for a particular volcano; and
- explain the relationship between volcanic eruptions and climate.

Tsunami hazards

In this units, students will

- calculate the speed of a tsunami wave and the time it takes to travel a specific distance;
- explain how the amplitude and speed of a tsunami wave vary between shallow water and deep ocean water and the causes of these changes;
- explain why the first tsunami wave may not be the largest or most dangerous; and
- describe hazards associated with tsunamis.

- In Unit 3, **Earthquake hazards**, students examine earthquake data to locate the largest and most damaging earthquakes. They explore trends in deadly earthquakes throughout history. Students learn about factors that affect earthquake destruction, and they learn about recurrence intervals and how to use them to predict future risks. Finally, they examine the relationship between population, national wealth, and seismic risk.
- In Unit 4, **Volcano hazards**, students study historical volcanoes, learn about the volcanic explosivity index (VEI) scale, and determine the recurrence interval for volcanic eruptions. They become familiar with different types of volcanic eruptions and investigate the effect of major eruptions on climate. Students conclude the unit with an examination of large (VEI 7-8) eruptions and learn how far the effects of the eruptions can spread.
- In Unit 5, **Tsunami hazards**, students are introduced to tsunamis and their behavior by analyzing two major tsunami events. Students learn what tsunamis are, how they form, how they affect communities, and how communities can prepare for tsunami events. Finally, students study the interaction between tsunamis and tides and examine tsunami trigger events with the goal of developing criteria to use to issue tsunami warnings.