GRADE LEVEL: 6-8 | TIME REQUIREMENT: 2 HOURS

EARTH AND SPACE SCIENCE: PLATE TECTONICS

1 READING | 1 ACTIVITY

INTRODUCTION

The vast Pacific Ocean and the islands scattered across it were almost as tough an enemy as the Japanese forces that controlled much of that territory during World War II. Those islands were formed by forces not fully understood by science until decades later. The "Ring of Fire" is a term used to describe a huge circle of volcanic activity that forms a ring around the Pacific, from New Zealand in the south to the Aleutians in the north. In the region where most of the US battles in the Pacific during World War II took place, there are many active volcanoes, and there were dozens of earthquakes during that time. The islands varied greatly in their physical geography—in a manner that was only understandable once the theory of plate tectonics was formalized in the late 1960s.

The many volcanoes of the western Pacific are formed through a process known as subduction where one continental plate moves under another and sinks into the earth's mantle; magma from the subducted crust then bubbles up to the surface.

Most of the islands in this Ring of Fire formed when undersea volcanoes emerged from the ocean. Over time, coral reefs formed around them, and the volcanoes eroded to form rich soils. The youngest islands have high elevation and active volcanoes. The oldest have only a ring of reefs remaining. These oldest islands are referred to as atolls.

OBJECTIVE

Use these two resources to show the pattern of volcanoes and earthquakes in the South Pacific and then learn and make diagrams about plate tectonics. These are reversed in order from most of our sets—we suggest you use the activity first and then the reading. You can supplement with physical maps from these areas, and even use maps of volcanoes and at other plate boundaries as an extension.

STANDARDS

NGSS DCI ESS2.B
Plate Tectonics and Large-Scale System Interactions

NGSS DCI ESS3.B
Natural Hazards

NGSS SEP
Analyzing and Interpreting Data

NGSS SEP
Engaging in Argument from Evidence

NGSS CCC
Patterns

NGSS CCC
Stability and Change

PERFORMANCE EXPECTATIONS

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.

MS-ESS3-2
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

READING (1)

1. GEOLOGY AND HISTORY

Description
This resource is a reading for students to understand how active geologic features like volcanoes and earthquakes shaped some of the events in World War II. It has descriptions of the geologic forces acting in a region, and asks students to make a diagram based on the descriptions.

Supplies
Paper and colored pencils
Physical maps of the Philippines and Italy (optional)

Instructions
Have the students read the handout, then discuss it in small groups or the whole class. Have them follow the instructions to make a geologic diagram. The optional maps may help them to understand the plate tectonic forces in the regions discussed.

ACTIVITY (1)

1. MAPPING DANGER

Description
This is an activity in which students map volcanoes and earthquakes using a table of data. Students will explore and explain the pattern as seen in the data that they map.

Supplies
Pencils or pens in contrasting colors
Map of the South Pacific (that includes latitude and longitude grids)

Instructions
Show students how to use the latitudes and longitudes to locate the spots on the map. Have them mark earthquakes in one color and volcanoes in a contrasting color. To lighten the work load you could divide the data up so that some groups only do some lines of the data, and then put them together to make the bigger picture. With small modifications you could use Google Maps to map the data. In this case you need to change all S latitudes to a negative value.

READING

GEOLOGY AND HISTORY

On September 1, 1923, at 11:58 a.m., an earthquake with a magnitude of 7.9 occurred in a bay just south of Tokyo, Japan. Tokyo and Yokohama, a relatively young port city with a strong international influence, were the closest large population centers. After the earthquake struck, a tsunami with an 11-meter-high crest hit Yokohama and surrounding areas. Fires spread throughout Tokyo and Yokohama, and with water mains broken by the quake, there was no way to fight them. The earthquake lifted the shoreline up two meters higher compared to sea level and made a crack in the earth that was 4.5 meters wide.

Even though the earthquake lasted only 14 seconds, there was a huge amount of energy released: 570,000 homes were destroyed and more than 140,000 people were killed. With telegraph technology connected to radio, news from Japan to the countries of the West moved rapidly. The United States and other countries mobilized support for victims of the earthquake within 24 hours. Japan had annexed Korea more than a decade earlier, and in the months before, what came to be called the Great Kanto Earthquake, a group working for the liberation of Korea had been conducting terrorist attacks. Rumors spread in the aftermath of the quake that Koreans were looting and starting fires. Violent attacks on Koreans and anyone thought to be Korean followed. The Japanese government tried to protect Koreans, but also covered up any attacks that occurred. This event, and Japan's dependence upon the West for support in recovery, fueled growing nationalism. This influenced Japanese imperialism and expansionism in the decades before World War II.

Vesuvius erupting in the background as a truck passes. Naples, Italy, March 1944. *(Image: The National WWII Museum, 2007.243.080.)*

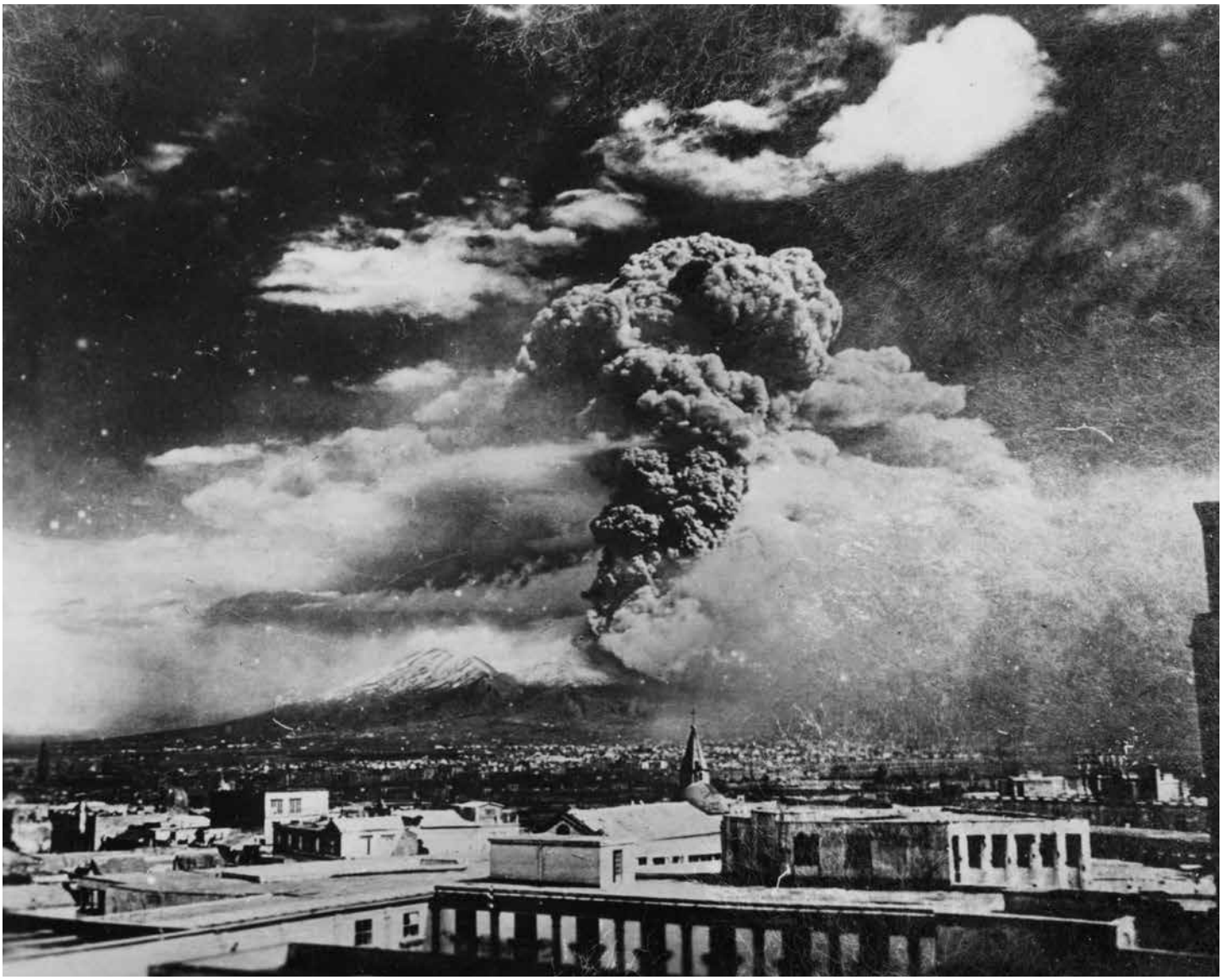
Earthquakes and volcanoes were, and still are, common in the Pacific. These geological factors shaped the Pacific islands, and when US troops fought there in World War II, these conditions shaped logistics and even the path of the war. There is a diamond-shaped continental plate—the Philippine plate—pinned between the much larger Pacific and Eurasian plates. The Pacific plate is moving slowly but relentlessly west, pushing the Philippine plate ahead of it. Where the plates meet, the Pacific sinks below both the Philippine and Eurasian plates, and the Philippine plate dives under the Eurasian plate. This pattern of plate convergence is called subduction and leads to earthquakes and volcanoes. Where the plates come together in the ocean, they form volcanoes, which can emerge from the ocean, slowly over time, creating islands. From New Guinea to the Marianas and Iwo Jima (on the east side between the Philippine and Pacific plates), from the Philippines to Okinawa and north (on the west side, between the Eurasian and Philippine plates), and to Japan (split by the Eurasian and Pacific plates), all of these islands were formed from volcanic activity. Some of those islands are very old, their volcanoes mostly dead. Coral reefs surround these islands (like Tinian or the Bikini atoll). Others are younger and form very high tropical peaks (like in the Philippines).

Iwo Jima, which in its original Japanese name means "sulfur island," was formed by slightly different volcanic activity that led to its peculiar geography. There is abundant groundwater on Iwo Jima, all of it very hot and enriched with minerals. The frequent volcanic activity there is mostly steam created by the interaction of groundwater and magma (molten rock).

The geological theory that explained volcanoes and earthquake patterns, called plate tectonics, wasn't solidified until the late 1960s. US troops went into this zone, where there were more than two dozen large earthquakes (> 6.0) between 1940 and 1946. Imagine the uncertainty this caused without any way to predict what was going on or without or any understanding of what each stop on the island-hopping path to Tokyo would bring.

Put together your knowledge of plate tectonics and the information in the passage you just read above. Draw a cross-section of the crust showing how the Pacific Plate, the Philippines Plate, and the Eurasian Plate interact. Indicate where volcanoes might form and earthquakes might occur.

NAME: **DATE:**



A huge plume of volcanic ash from Vesuvius in the background of an image taken of Naples, Italy, March 1944.
(Image: The National WWII Museum, 2009.046.219.)

Far, far away, in Europe, on March 17, 1944, Mount Vesuvius erupted. Mount Vesuvias is the volcano that destroyed Pompeii and other Roman cities in 79 CE. The volcano, which is in southern Italy near the western coast, is a very different kind of volcano than the ones you mapped in the Pacific.

Italy had surrendered to the Allies, but German forces still held the north of the country. A US air base was near Vesuvius, and the planes on the airstrip there were seriously damaged by the eruption.

Do some research and try to figure out why there is a volcano in Italy. Are there others in Italy? Are there others in the Mediterranean region? Can you use plate tectonics to explain their pattern?