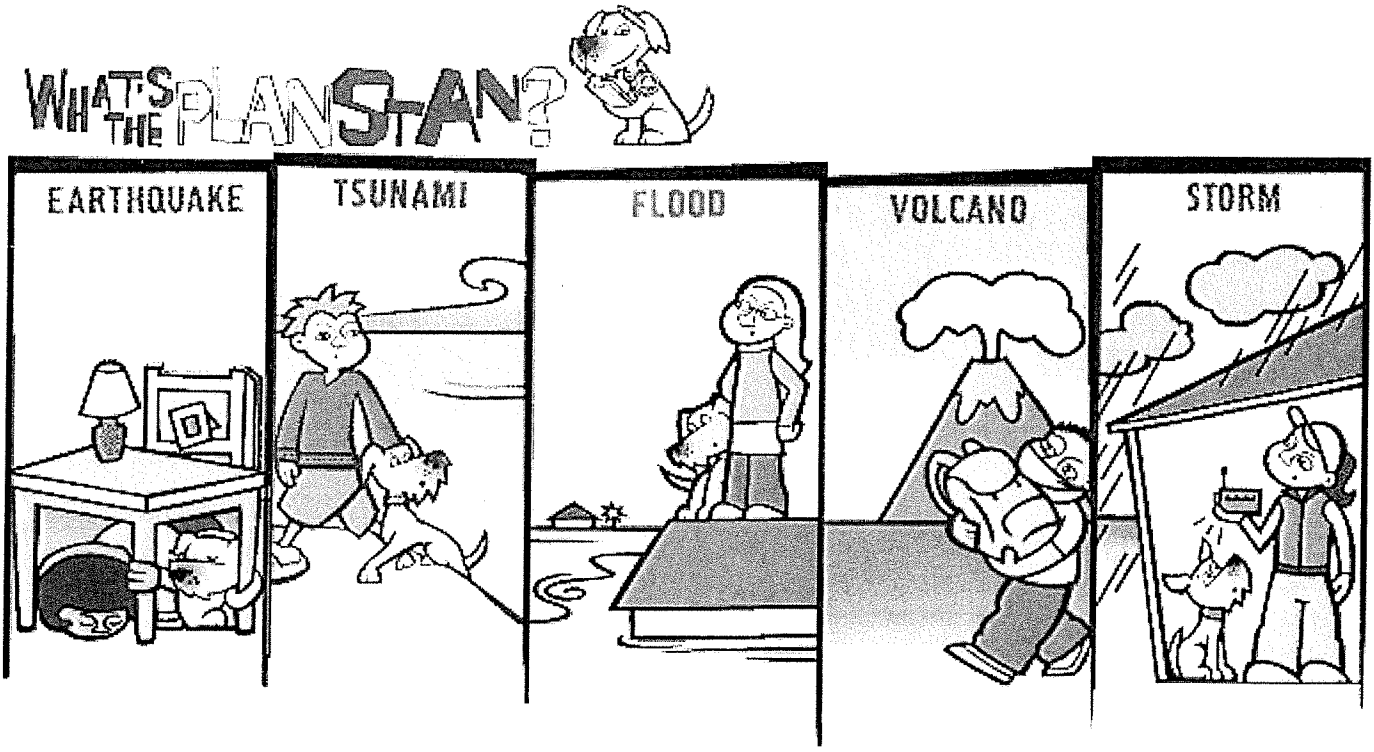
Unit 7:

Earth's Natural Hazards



Lesson 1: Natural Hazards

Lesson 2: Natural Hazards Predictions

Name: _____

Teacher: _____ PD:___

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Unit 7: Lesson 1 Vocabulary

1 Natural Hazard:	
2 Natural Disaster:	
3 Volcano:	
4 Volcanic Eruption:	
5 Active Volcano:	
6 Dormant Volcano:	
7 Tsunami:	
8 Tornado:	

4

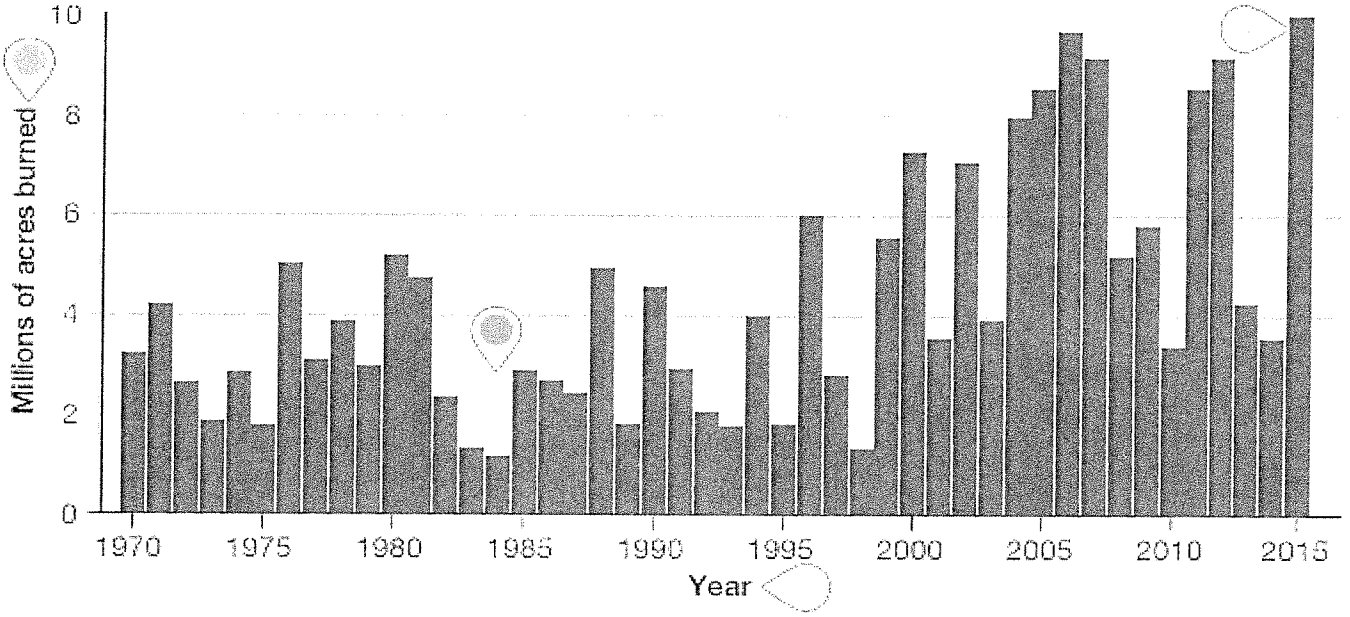
Here are some questions to consider as you work through the unit. Can you answer any of the questions now? Revisit these questions at the end of the unit to apply what you discover.

What types of natural hazards are likely where you live?	
How could the natural hazards you listed above cause damage or injury?	
What is a natural disaster?	
What types of monitoring and communication networks alert you to possible natural hazards?	
How could your home and school be affected by a natural hazard?	
How can the effects of a natural disaster be reduced?	

Unit Starter: Analyzing the Frequency of Wildfires 5

Analyzing the Frequency of Wildfires

Wildfires occur every year in the United States. They can be caused by lightning strikes or by people who do not put out their campfires completely. When these fires occur, they can destroy many acres of natural land and the habitats of the animals living there.



Source: National Interagency Fire Center, Historical Wildland Fire Information, as quoted by Brian Kahn, 2016. "The 2015 Wildfire Season Sets an Ominous Record." Climate Central

- The y-axis shows how many acres were burned in millions of acres.
- The x-axis shows the year when the wildfires occurred.
- In 1984, fewer than two million acres burned, which is the lowest amount between 1970 and 2015.
- In 2015, 10 million acres burned for the first time on record.

Choose the correct phrases to complete the statements below:

Between 1970 and 1990, on average **fewer than / more than** 5 million acres burned in wildfires each year.

Between 2000 and 2015, more than **5 million / 10 million** acres burned in more than half of the years.

Overall, the number of acres burned each year has been **increasing / decreasing** since 1970.

Lesson 1: Natural Hazards

In 2015, this wildfire near Clear Lake, California, destroyed property and devastated the environment.

Can You Explain it?

In the 1700s, scientists in Italy discovered a city that had been buried for over 1,900 years. As they dug down to see more and more of the city, they discovered that the buildings and other structures were still standing. And it appeared that the city had been buried very suddenly. There were cavities in the ground in the shapes of people and animals all over the city. The city's inhabitants had been buried suddenly, and over hundreds of years the bodies had decayed. Scientists began filling the cavities with plaster or cement and letting it dry. Then they carefully removed the material around the cement so they could see the shape of the cavity. One of these cement casts is shown in the photo.

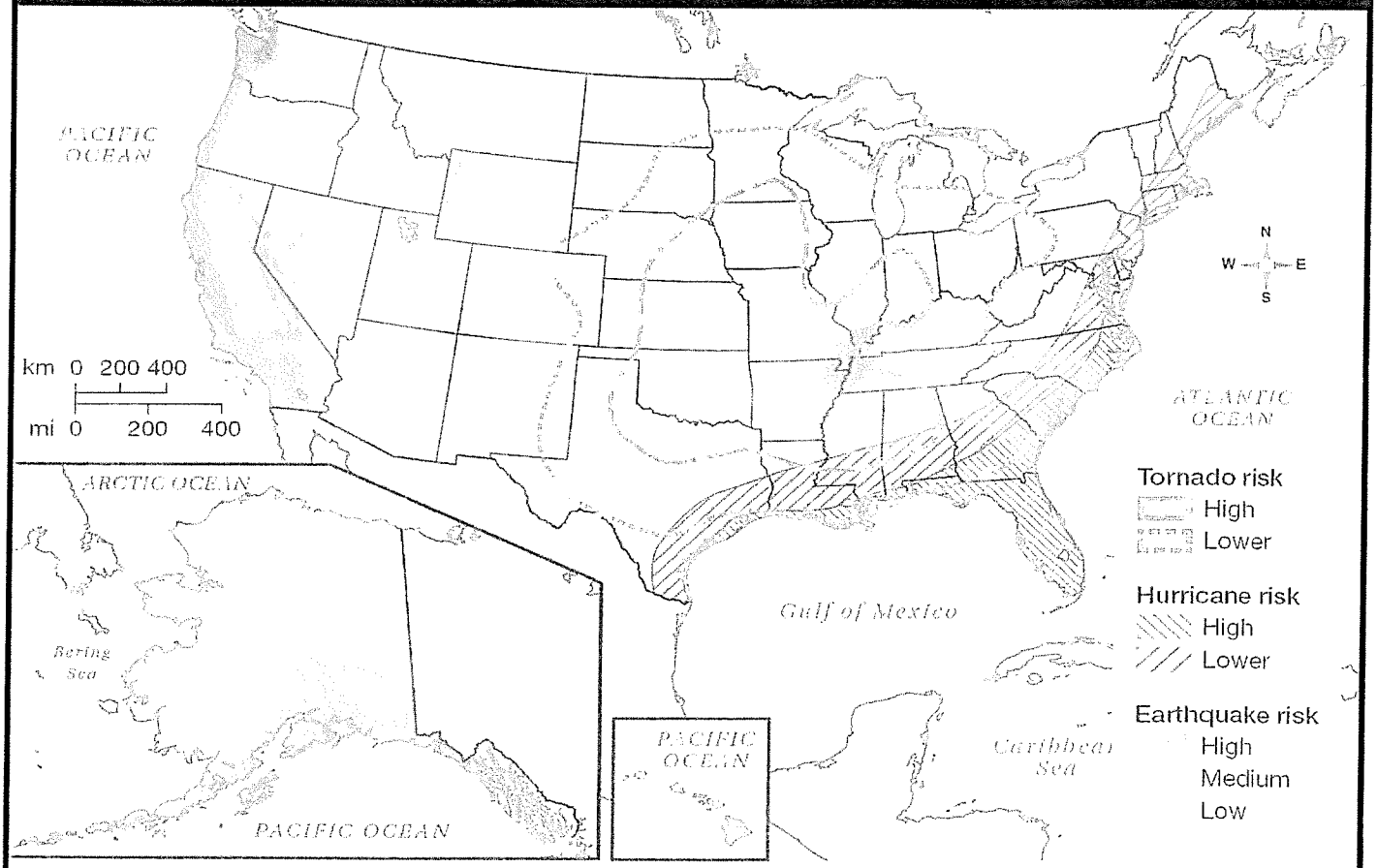
What could have buried this city and its people so suddenly?

Natural Hazards and Natural Disasters 7

A naturally occurring event that can have a negative effect on humans or the environment is called a **natural hazard**. Natural hazards include floods, storms, droughts, avalanches, wildfires, earthquakes, tsunamis, hurricanes, tornadoes, and volcanic eruptions. Natural hazards also include the spread of disease and space-related hazards such as meteorite impacts. Humans cannot control the causes of natural hazards. However, understanding these events can help humans find ways to make these events less destructive. Humans can identify areas where natural hazards are likely to occur and find ways to prepare for these events.

Any natural hazard can become a **natural disaster** if it causes widespread injury, death, or property damage. A natural disaster may occur in only one small area, or it may cover large areas—even several countries.

Natural Hazards Risk in the United States



Source: The New York Times, based on data from NOAA, University of Miami, U.S. Geological Survey

1. Name three types of Natural Disasters that occur in the U.S.
   -
   -
   -

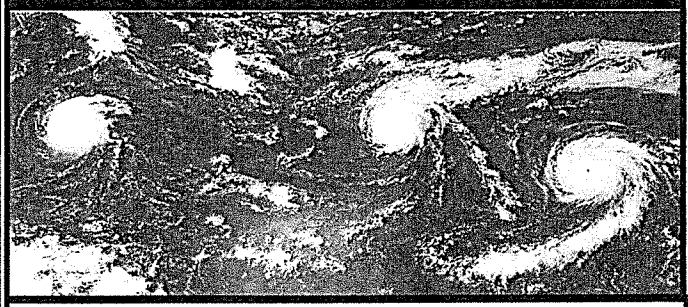
8 Types of Natural Hazards

There are many types of natural hazards. Weather hazards include thunderstorms, tropical storms, lightning, and tornadoes. Too much rain can cause floods, erosion, and landslides. Too little rain can cause droughts, which are climate hazards. Geologic hazards include earthquakes and volcanic eruptions. Earthquakes can cause ground shaking, landslides, and tsunamis. Volcanic eruptions can bring molten rock, hot gases, and volcanic ash to Earth's surface. Other types of natural hazards include wildfires, space-related hazards such as asteroid impacts, and widespread diseases.

Worldwide Natural Disasters

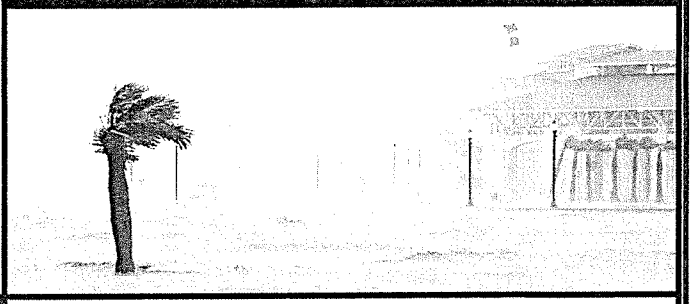
As the human population increases, the number of natural disasters increases as well. Whenever a natural hazard affects a heavily populated area, the chance of it becoming a natural disaster increases.

Sometimes, hurricanes occur over the ocean and never reach land. This satellite image shows several large hurricanes.



This is an example of a **Natural Disaster / Natural Hazard**

This photo shows Hurricane Isaac when it struck Gulfport, Mississippi in 2012.



This is an example of a **Natural Disaster / Natural Hazard**

Worldwide Natural Disasters (1995 – 2015)

Natural hazard type	Number of occurrences	Percentage of total (%)
flood	3,062	43
storm	2,018	28
earthquake	562	8
extreme temperature	405	6
landslide	387	5
drought	334	5
wildfire	251	3
volcanic eruption	111	2

1. What is the most common type of natural disaster?
2. What is the least common type of natural disaster?
3. How many Landslides occurred?

Types of Natural Hazards

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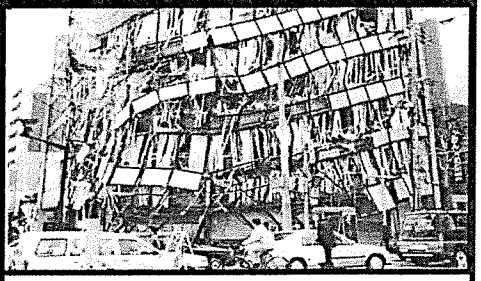
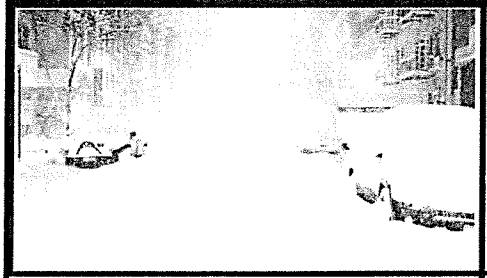
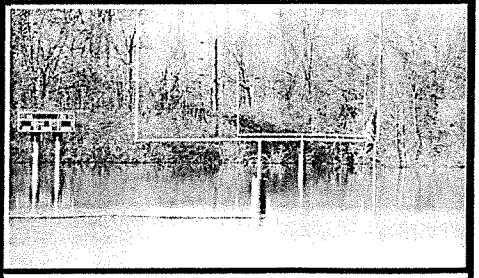
Geologic Hazards

Geologic hazards are caused by geologic processes such as plate motion. Some geologic hazards, such as landslides, earthquakes, tsunamis, and volcanic eruptions, can happen quickly or without warning.

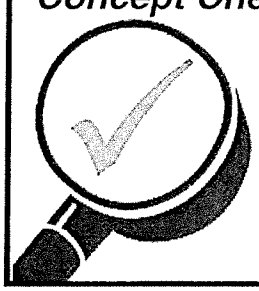
Tsunami	Sinkhole	Earthquake
		
A tsunami is a powerful wave caused by movement of ocean water after an earthquake, a landslide, or an eruption.	When groundwater dissolves rock below the surface, the ground can suddenly collapse to form a sinkhole.	Earthquakes occur when slabs of Earth's crust move and release energy, causing violent shaking.

Weather and Climate Hazards

Weather describes the conditions in the atmosphere at any given time. ***Climate*** describes long-term weather patterns. Weather and climate hazards include droughts, hurricanes, tornadoes, blizzards, severe thunderstorms, and floods. Severe storms can have heavy rain, lightning, high winds, and hail, and they can lead to tornadoes and floods.

Blizzard	Drought	Flood
		
Very cold temperatures and strong winds combined with extreme amounts of snowfall cause a blizzard.	During a drought, too little rain causes the land to dry out, and plants are unable to get the water they need.	When heavy rain cannot soak into the ground it runs over Earth's surface and causes a *flood*.

Concept Check



What kinds of natural hazards could suddenly bury a city and the people who live there?

10 Natural Hazards Data

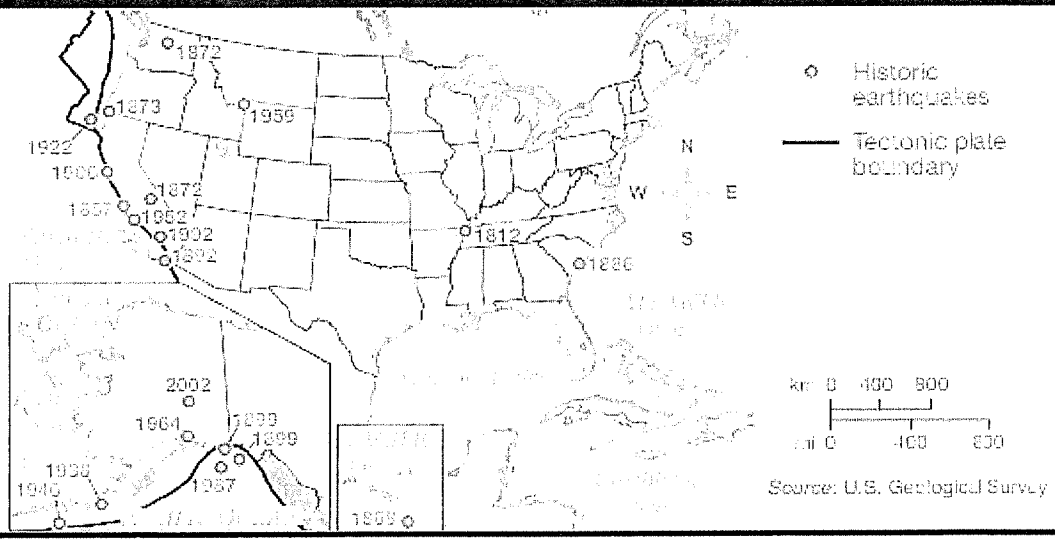
Historical data from past natural hazards help us understand the causes and effects of natural hazards and allow us to see patterns in hazard occurrences.

Depending on the natural hazard, data could include location, time, and duration. It may also include *frequency*, or how often events occur, and *magnitude*, or how large events are.

Current conditions are also monitored to learn about natural hazards. For example, weather instruments collect data on current atmospheric conditions. Meteorologists analyze these data to determine when and where a storm might occur.

Historic Earthquakes in the United States

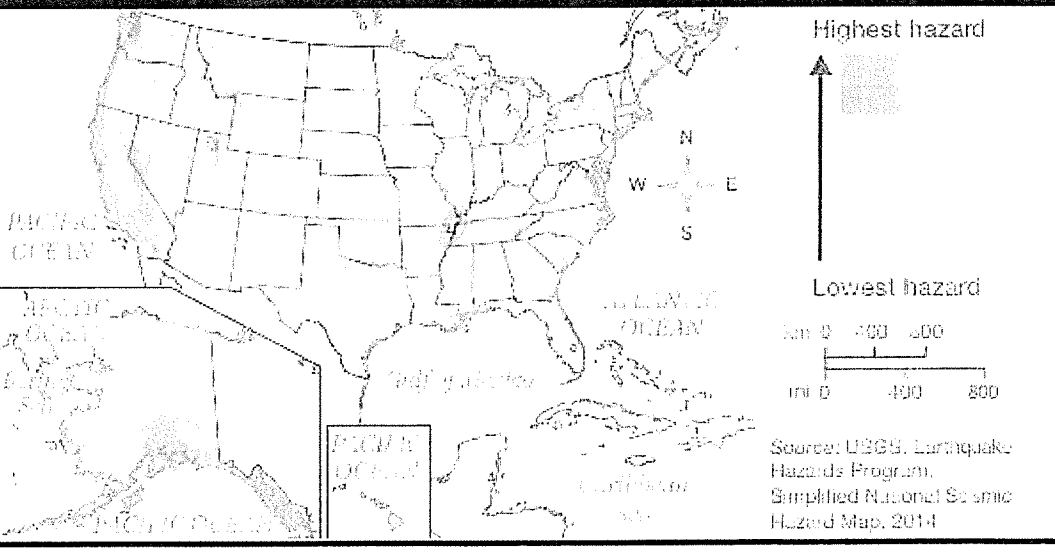
This map shows the locations of some significant earthquakes that have happened in the United States since the 1800s. It also shows the locations of tectonic plate boundaries.



Source: U.S. Geological Survey

Earthquake Hazard Areas in the United States

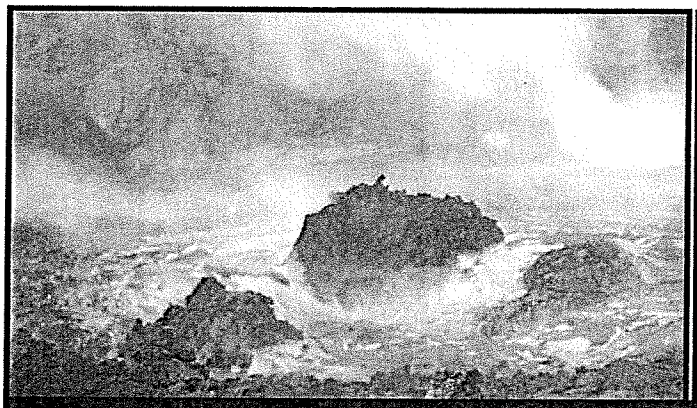
This map shows how probable a future earthquake is within the United States.

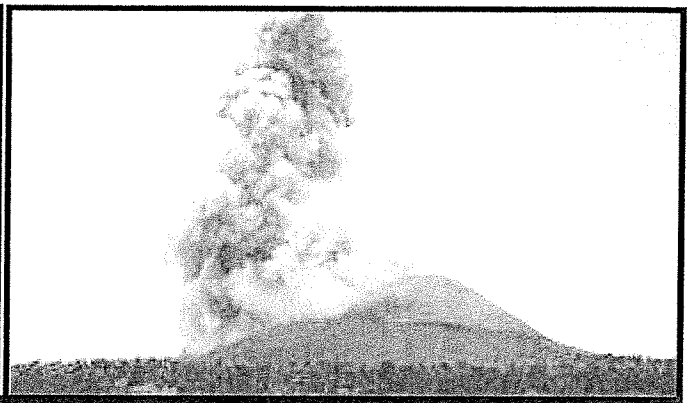


Source: USGS, Earthquake Hazards Program, Simplified National Seismic Hazard Map, 2014

Volcanoes 11

A *volcano* is a place where molten rock and gases can rise from Earth's interior to the surface. Volcanoes are located on continents and at the bottom of the ocean. Some volcanoes are tall mountains, while others are just cracks in Earth's surface. A *volcanic eruption* is a geologic hazard in which molten rock—called *magma* or *lava*—gases, ash, and other materials are released onto Earth's surface and into the atmosphere.





Complete the paragraph to compare eruption types

During **quiet / explosive** eruptions, lava oozes downhill.

During **quiet / explosive** eruptions, lava, ash, and gases shoot into the air.

When a volcano erupts, molten rock reaches Earth's surface. Once at the surface, the molten rock is called *lava*. Not all volcanic eruptions are the same. Some are explosive, forcefully throwing hot lava, ash, and gases into the air. **Volcanic eruptions** may also be quiet or slow, with lava oozing out and flowing downhill.

Volcanoes erupt on Earth every day, but most eruptions are small or far from human populations. Only some of Earth's volcanoes have erupted in the past 10,000 years. These are considered ***active volcanoes.*** Those that have not erupted in the past 10,000 years are considered ***dormant volcanoes.*** If geologists agree that a volcano is not likely to erupt ever again, it is considered an *extinct volcano.*

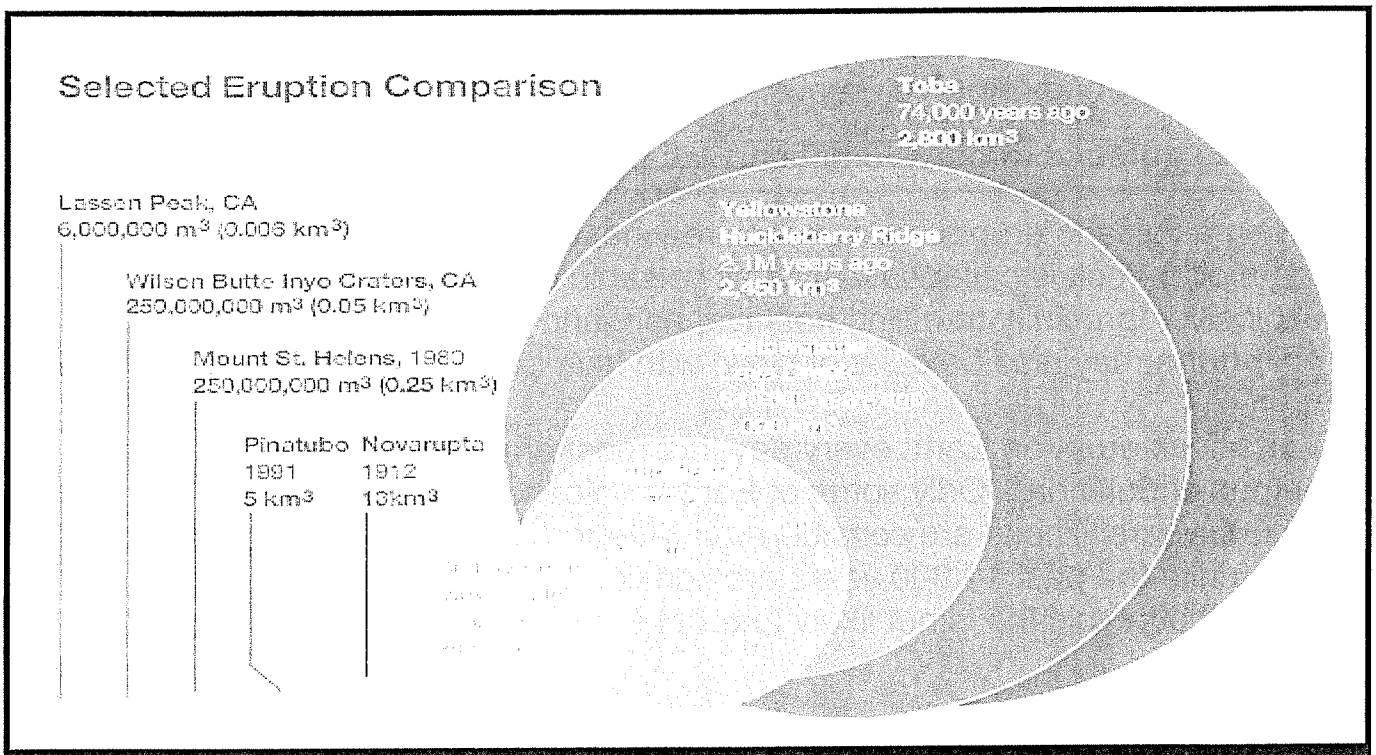
Volcanic eruptions are natural disasters when they occur near populated areas and cause property damage, injury, or death. Ash from explosive eruptions can be spread by wind in the atmosphere and partially block sunlight, lowering Earth's temperature over a period of months to years. Volcanic ash can also contaminate water supplies. Large eruptions may cause earthquakes and tsunamis. Shaking from earthquakes can damage buildings and roads. ***Tsunamis*** are powerful ocean waves that can flood coastal areas.

12 Volcanic Explosivity Index (VEI)

Scientists compare the magnitudes of volcanic eruptions by using the Volcanic Explosivity Index (VEI). The scale starts at 0 and has no upper limit. The largest known eruption had a magnitude of 8.

Volcanic Explosivity Index (VEI)			
0	nonexplosive	0.000001	<0.1
1	gentle	0.00001	0.1–1
2	explosive	0.001	1–5
3	severe	0.01	3–15
4	cataclysmic	0.1	10–25
5	paroxysmal	1	>25
6	colossal	10	>25
7	super-colossal	100	>25
8	mega-colossal	1,000	>25

This diagram compares the sizes of some of Earth's major volcanic eruptions from the past few million years.



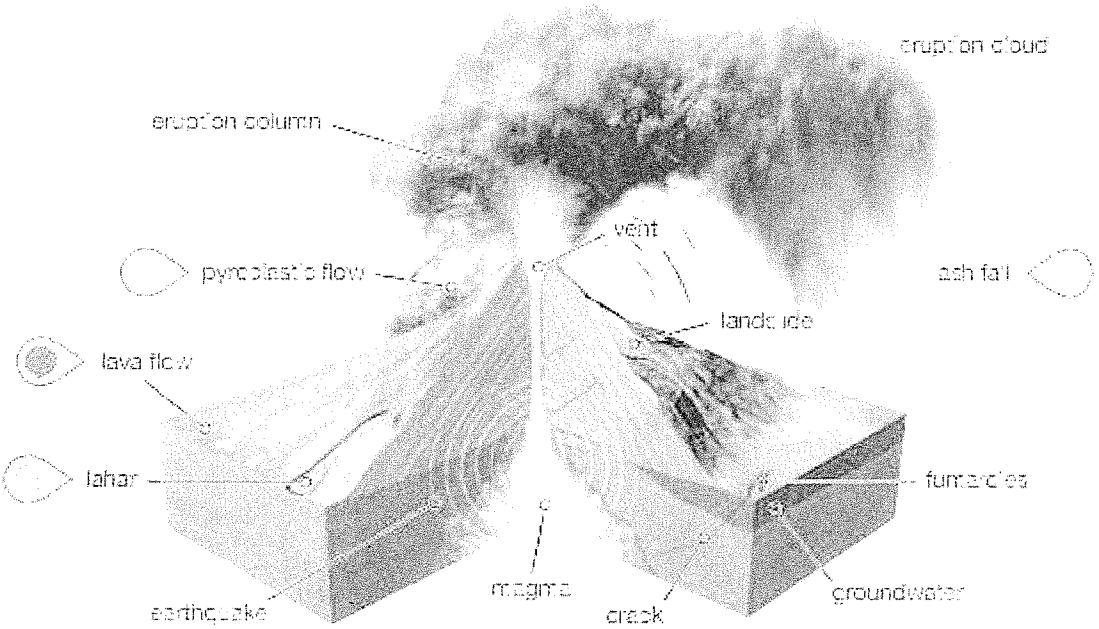
Complete the paragraph to compare eruption types

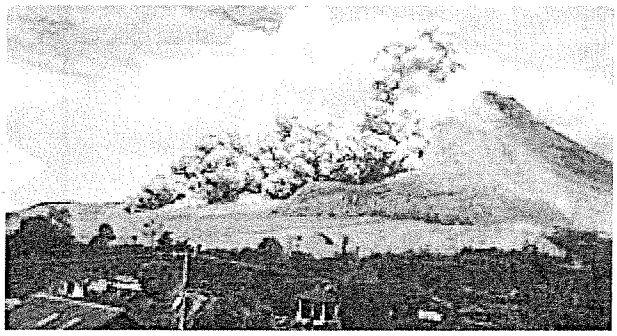
Mount Pinatubo erupted in 1991, releasing 5 km^3 of material. This would rate as a(n) **3 / 4 / 5 / 6** eruption. The Long Valley Caldera eruption ejected 580 km^3 of material, more than 100 times the amount that Pinatubo released. This eruption would rate as a(n) **4 / 5 / 6 / 7** on the VEI and is therefore categorized as a(n) **paroxysmal / colossal / super colossal / mega colossal** eruption.

Volcanic Hazards 13

Volcanic Hazards

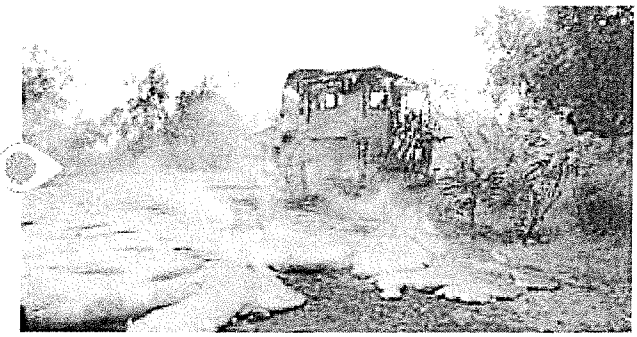
The diagram and photos illustrate some of the hazards associated with a volcanic eruption.



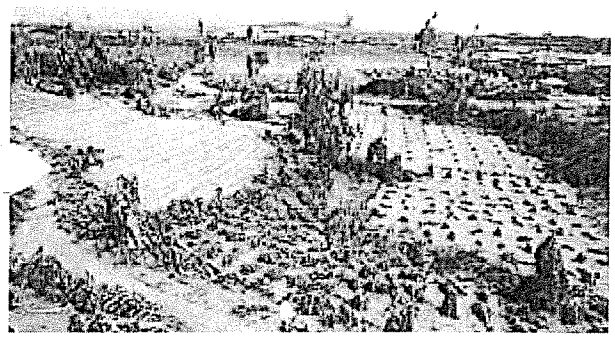


A *pyroclastic flow* can destroy buildings, forests, and croplands and can kill living things. Pyroclastic flows can travel at speeds of up to 700 km/h.

A *lahar* is a mudslide that is like a flood of concrete. A lahar can travel at speeds up to 200 km/h and can crush or carry away everything in its path.



Lava can surround and cover objects in its path. When lava cools, the objects are buried under hardened rock. Lava can flow at speeds up to 60 km/h and can also trigger wildfires.



As volcanic ash falls from the sky for hours to weeks after an eruption, it can bury everything, including buildings, homes, forests, and crops.

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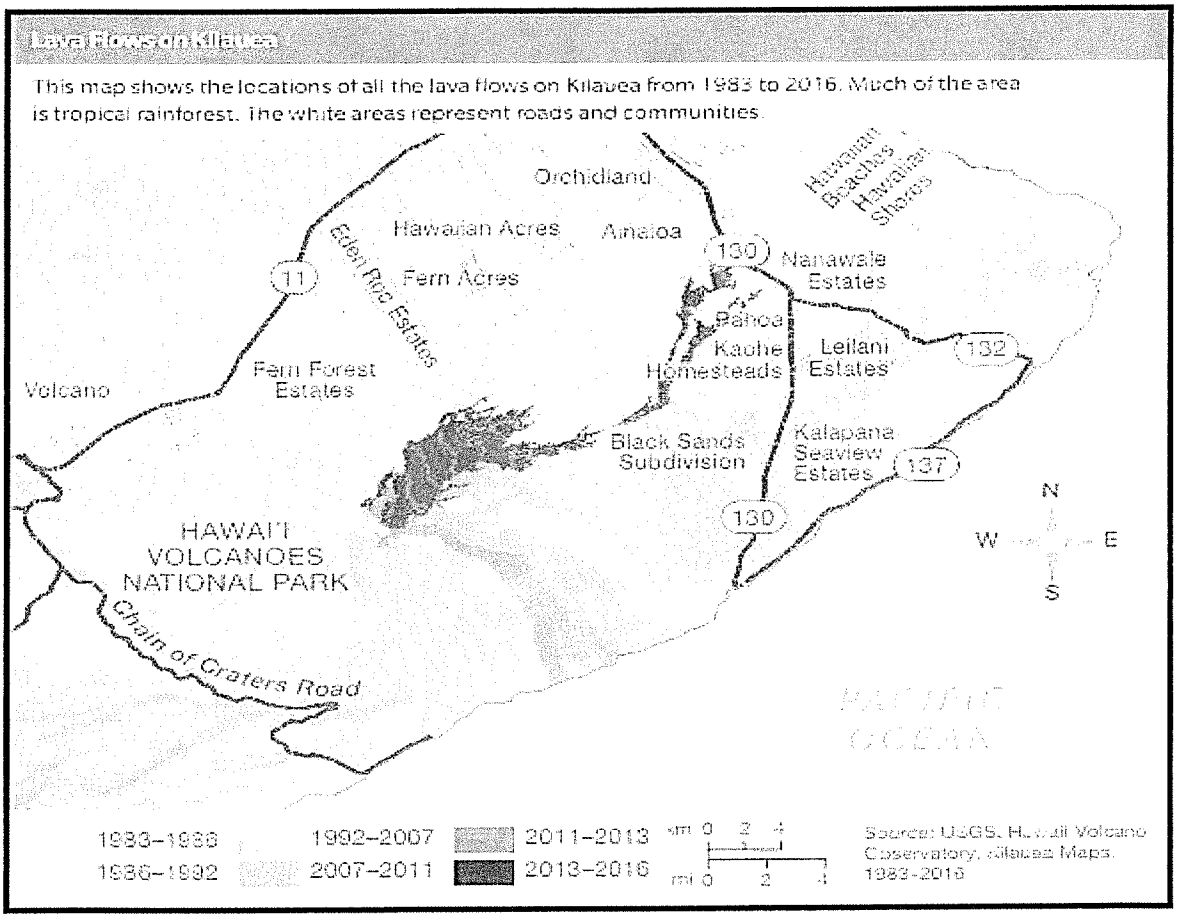
Lab Summary Page

Building Sites Near A Volcano

Lab Summary



1. **Place an X where you decided to build the hotel.**

2. **Why did you choose this location? Provide evidence.**

_____

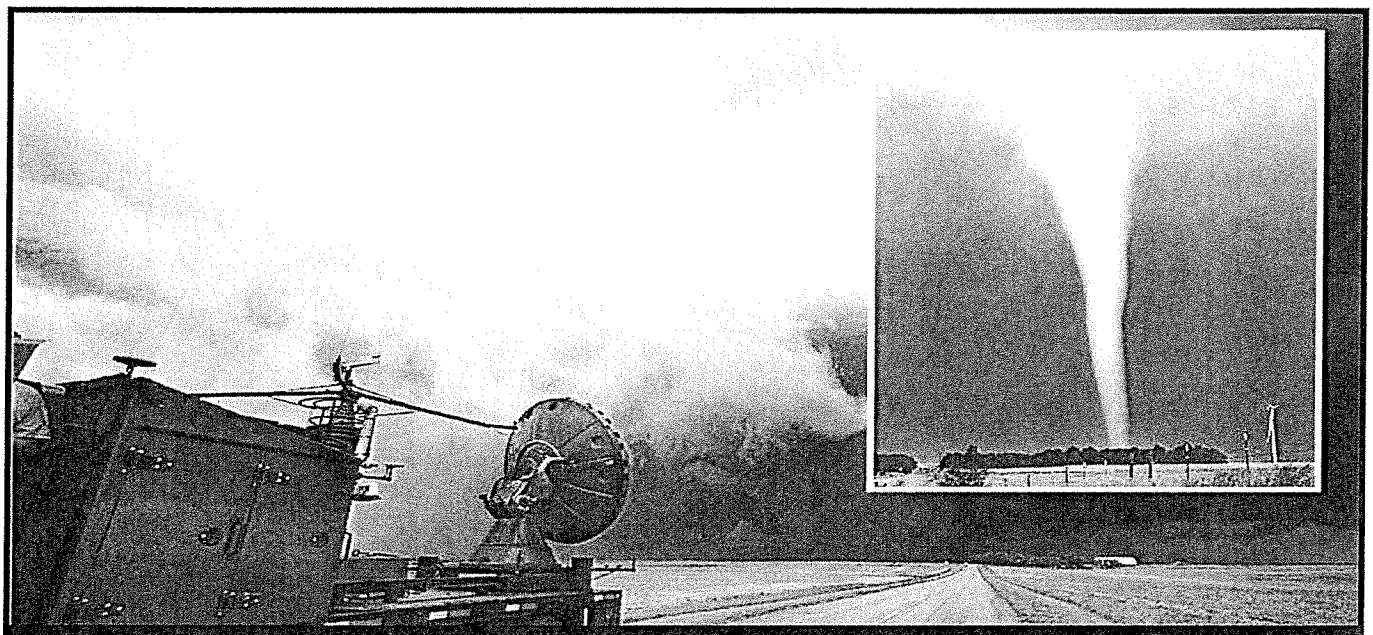
_____

_____

_____

Tornadoes 15

A ***tornado*** is a rapidly spinning column of air extending from a storm cloud to the ground. Tornadoes are weather hazards that are most common in spring and summer. This time of year is sometimes referred to as "tornado season."



This mobile Doppler radar truck was used to collect data from a storm in Nebraska that caused several tornadoes like the one shown in the inset. These data help scientists better understand how, when, and where tornadoes form and end.

Severe thunderstorms can bring heavy rain, hail, high winds—and tornadoes. Tornadoes can develop when rotating thunderstorms, called *supercells,* occur. However, not all supercells form tornadoes. A combination of factors must be present for a tornado to form. A body of warm, moist air must collide with a body of cooler, drier air. As a result, winds at different altitudes blow at different speeds and cause a column of air in the thunderstorm to spin. Because the air pressure is low in the middle of the spinning column, air in the middle of the column rises. The result is that the spinning column of air rotates in a vertical direction and drops below the thunderstorm to form a funnel cloud. When the funnel cloud touches the ground, it becomes a tornado.

A tornado can last anywhere from a few seconds to more than an hour. Most tornadoes last less than ten minutes. More than 1,000 tornadoes occur in the United States each year, but they are not evenly distributed across the country. Most tornadoes occur in the middle of continents.

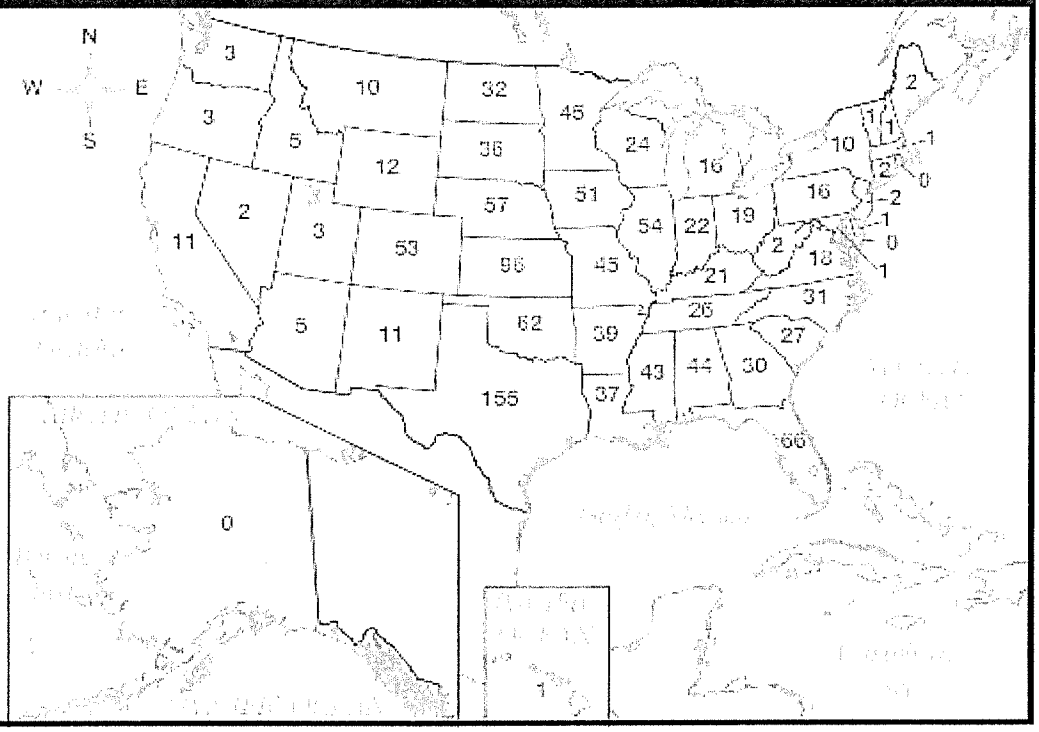
As you explore this section, think about whether a tornado could suddenly bury a city and its inhabitants. Record your evidence below.

16 Tornado Data and Scale

In the United States, the area where most tornadoes happen is called "Tornado Alley." You can find out about the average number of tornadoes per year in each state by studying the map.

Average Annual Number of Tornados in the United States (1991 – 2010)

This map shows the average number of tornadoes per year in each state. Color in the ten states that have the highest average number of tornadoes.



mi 0 400 800

km 0 400 800

Source: NOAA, Storm Prediction Center, "U.S. Annual Tornado Maps (1952–2011)"

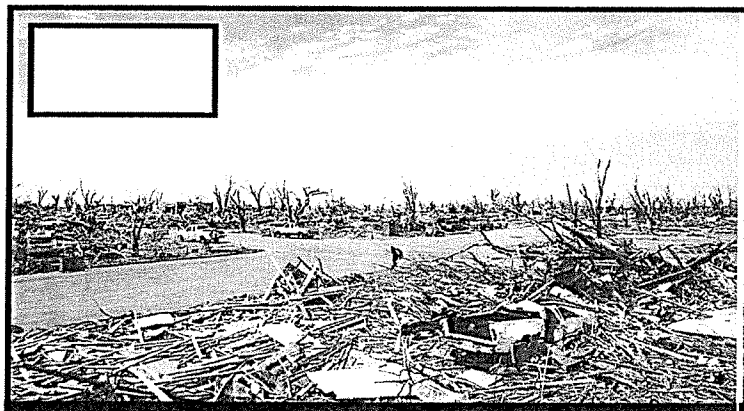
When a tornado strikes a populated area and is strong enough, it can cause damage, injury, or death. Its strong winds destroy many objects in its path, including buildings, roads, trees, crops, and sometimes people and other animals. A tornado that causes these types of damage is considered a natural disaster.

Meteorologists collect tornado data, such as a tornado's path, wind speeds, duration, and temperatures. Tornado data are also analyzed to identify areas at risk for tornado hazards and to make predictions about when and where tornadoes might occur. The Enhanced Fujita (foo•JEE•tuh) Scale below, also known as the EF Scale, describes tornado damage.

EF-0	105–137	Chimneys damaged; tree branches broken; shallow-rooted trees toppled.
EF-1	142–177	Roof surfaces peeled off; windows broken; some tree trunks snapped; garages may be destroyed.
EF-2	179–217	Roofs damaged; manufactured homes destroyed; trees snapped or uprooted; debris entered air.
EF-3	219–265	Roofs and walls torn from buildings; some small buildings destroyed; most forest trees uprooted.
EF-4	267–322	Well-built homes destroyed; cars lifted and blown some distance; large debris flew through the air.
EF-5	Over 322	Strong houses lifted, concrete structures damaged; very large debris flew through the air; trees debarked.

Tornadoes Data Comparison 17

The photos below show different places where a tornado occurred. How would you rate the damage based on the Enhanced Fujita (EF) Scale? Used the chart on page 16 to help you.



This tornado damaged all of the homes in this community and tossed large debris and several cars through the air.

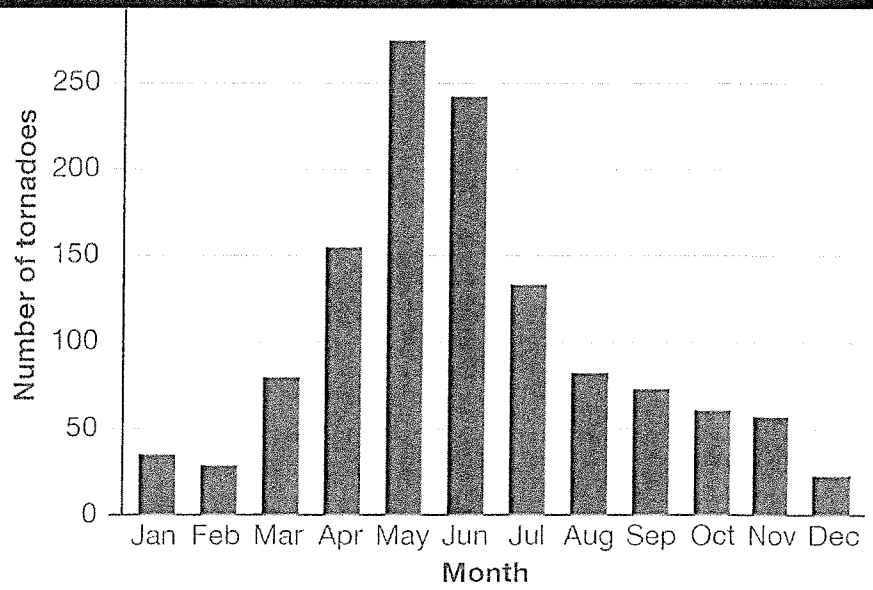
This tornado uprooted a few shallow-rooted trees and damaged many chimneys in the neighborhood.

Analyzing Tornado Data

A researcher wants to collect tornado data from the three states where tornado risk is highest.

Where and when should the researcher collect data? Support your claim by citing evidence from this graph and from the map of tornadoes in the United States.

Average Number of Tornadoes per Month in the United States (1991 – 2010)



Source: NOAA, National Climatic Data Center, "U.S. Tornado Climatology, Historical Records and Trends," 2011

18

Lab Summary Page

Tornado Alley

Lab Summary

1. **CLAIM:** Where is Tornado Alley?

_____

_____

_____

2. **EVIDENCE:** How do you know?

_____

_____

_____

3. **Which five states have the highest occurrence of tornados in the United states?** _____ , _____ ,

_____ , _____ , _____

4. **Do tornadoes occur where you live? Describe the risk.**

_____

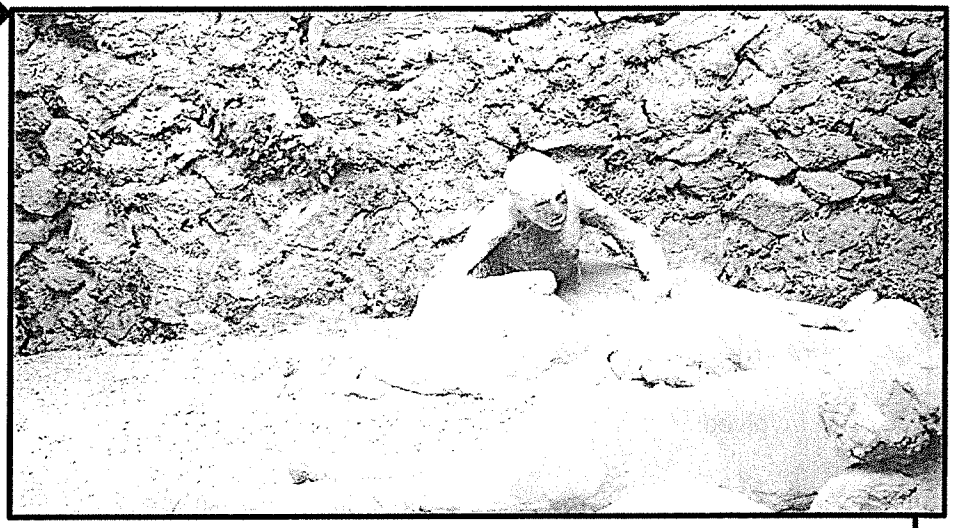
_____

_____

_____

Revisiting the Phenomena 19

Can You Explain It?



In the 1700s, scientists in Italy discovered a city that had been buried for over 1,900 years. As they dug down to see more and more of the city, they discovered that the buildings and other structures were still standing. And it appeared that the city had been buried very suddenly, and over hundreds of years the bodies had decayed. Scientists began filling the cavities with plaster or cement and letting it dry. Then they carefully removed the material around the cement so they could see the shape of the cavity. One of these cement casts is shown in the photo.

How was this city suddenly buried without warning?

1. State your claim. Make sure your claim fully explains what could have suddenly buried this city and its people and why the people were unable to escape.

2. Summarize the evidence you have gathered to support your claim and explain your reasoning.

20 Concept Review: Natural Hazards

Multiple Choice Review

1. What is NOT one of the four steps you can take to help your family be prepared for emergencies?

(1) Eat your vegetables

(2) Put together an emergency kit

(3) Make a plan

(4) Be informed

(5) Get involved

2. What is one of the most important actions to take before a volcanic eruption?

(!) Cover your garden with soil

(2) Keep goggles and a dust mask handy

(3) Read about volcanic eruptions in text books

(4) Evacuate the area

3. What is the main cause of tornadoes?

(1) Hurricanes

(2) Tropical Storms

(3) Thunderstorms

(4) Earthquakes

4. Which state in the United States has the highest number of reported tornadoes?

(1) New York

(2) Orgeon

(3) Minnesota

(4) Texas

5. Volcanoes are:

(1) Randomly distributed over the Earth's surface.

(2) Mostly located on Plate boundaries and Hot Spots

(3) Concentrated at the north and south poles.

(4) Located on the equator only.

6. Where are volcanic eruptions most likely to occur in the United States?

(1) Alaska and Hawaii

(2) Washington and Nebraska

(3) New York and New Jersey

(4) Georgia and Texas

7. A Tsunami is

(1) a result of an El Niño

(2) powerful ocean waves that can cause flooding

(3) A large amount of rainfall

(4) Shaking and moving of earth's crust

8. What type pf natural hazard

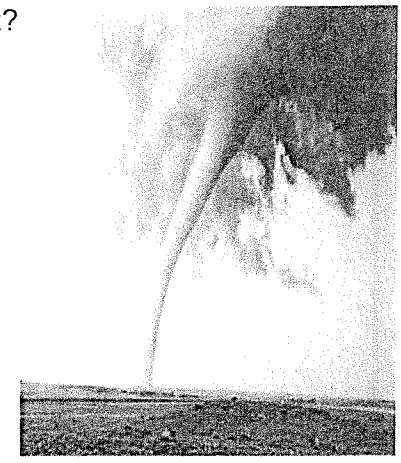
Is pictured to the right?

(1) Tsunami

(2) Earthquake

(3) Tornado

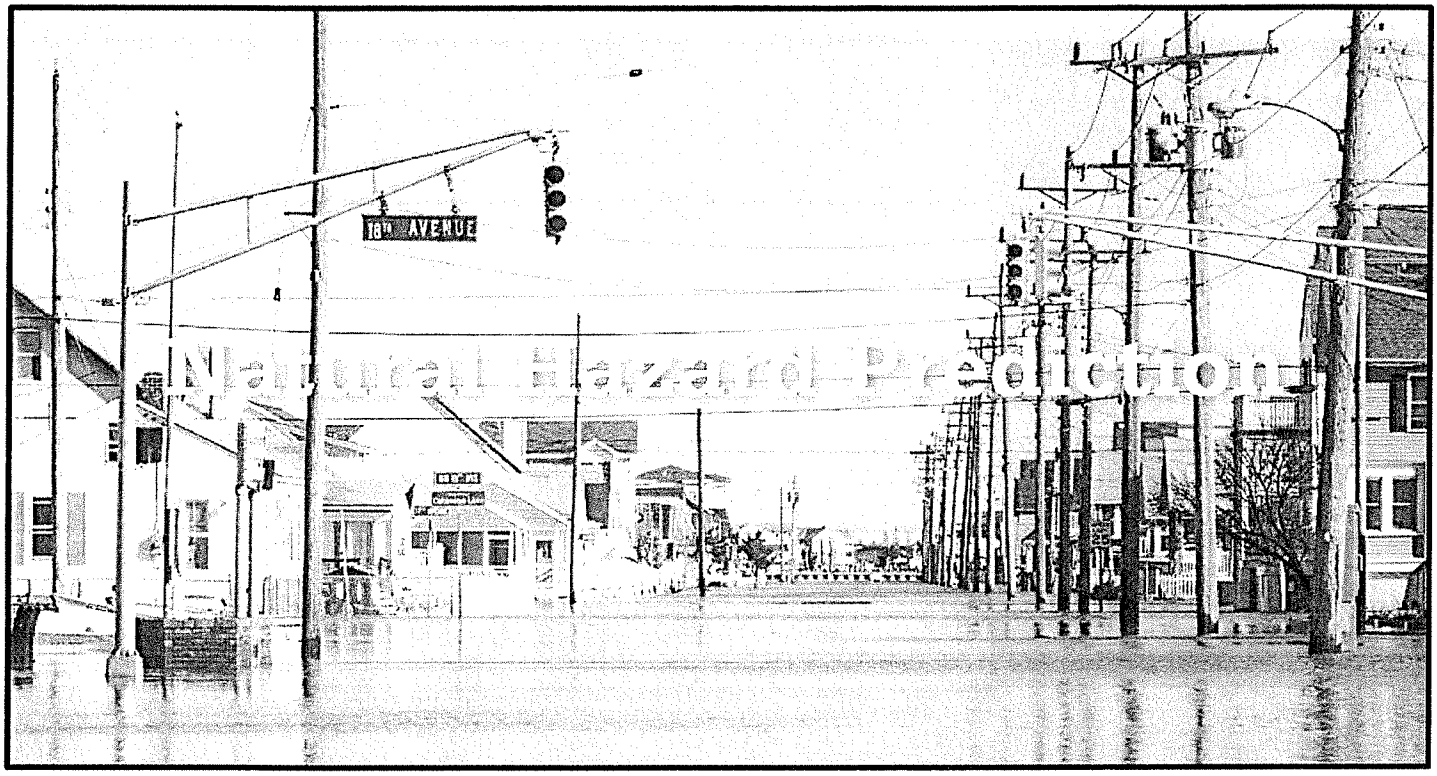
(4) Volcano



Unit 7: Lesson 2 Vocabulary

1 Natural Hazard Prediction:	
2 Geologic Hazards:	
3 Weather Hazards:	
4 Floods:	

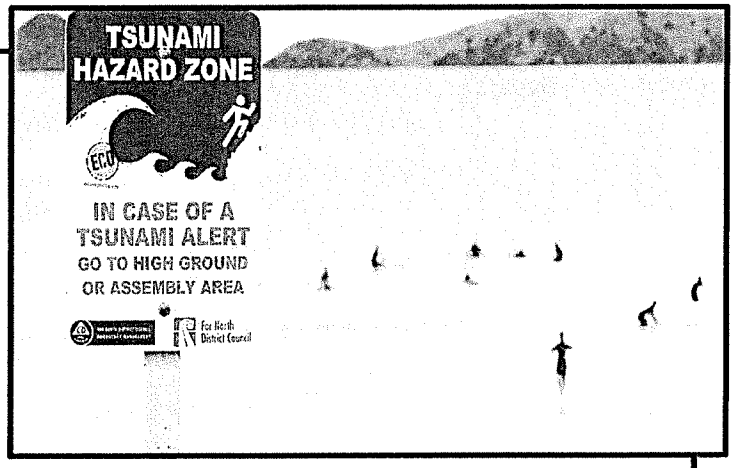
Lesson 2: Natural Hazard Prediction



Can You Explain it?

Why is there a tsunami hazard warning sign on this calm beach?

This beach on the east coast of New Zealand is a popular recreation spot. Some coastal areas are at a higher risk for tsunamis than others are.



How do we know which coastal areas are more likely to be affected by tsunamis?

Natural Hazard Prediction 23

Natural hazard predictions are efforts to forecast the occurrence, intensity, and effects of natural hazards. Some natural hazards are not predictable. Natural hazard predictions can help people reduce the effects of a natural hazard or even prevent some natural disasters.

Historical Data

Historical data are used to evaluate the likelihood that a natural hazard will happen in a given place. Historical data can include the locations of past events as well as their frequency, magnitude, and effects on the environment or people. Some hazards, such as volcanic eruptions, landslides, and earthquakes, tend to occur in specific areas. However, these hazards can happen at any time of the year. Hazards such as hurricanes and tornadoes tend to happen in specific places and during specific times of the year.

Historic Hurricane and Tropical Cyclone Paths

The lines on this map show the paths of past hurricanes and tropical cyclones. These data help us identify where hurricanes are likely to occur in the future.

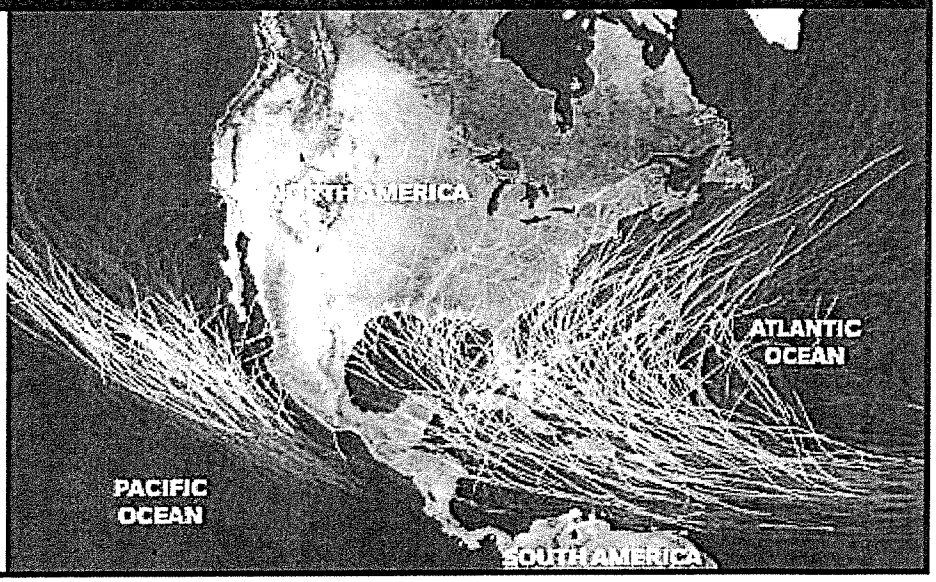
Hurricane Paths

Hurricane

Tropical cyclone (intensity below major hurricane)

Atlantic Ocean data: 1851–2013
Pacific Ocean data: 1949–2013

Source: NOAA, Major Hurricane History of the U.S., 2013

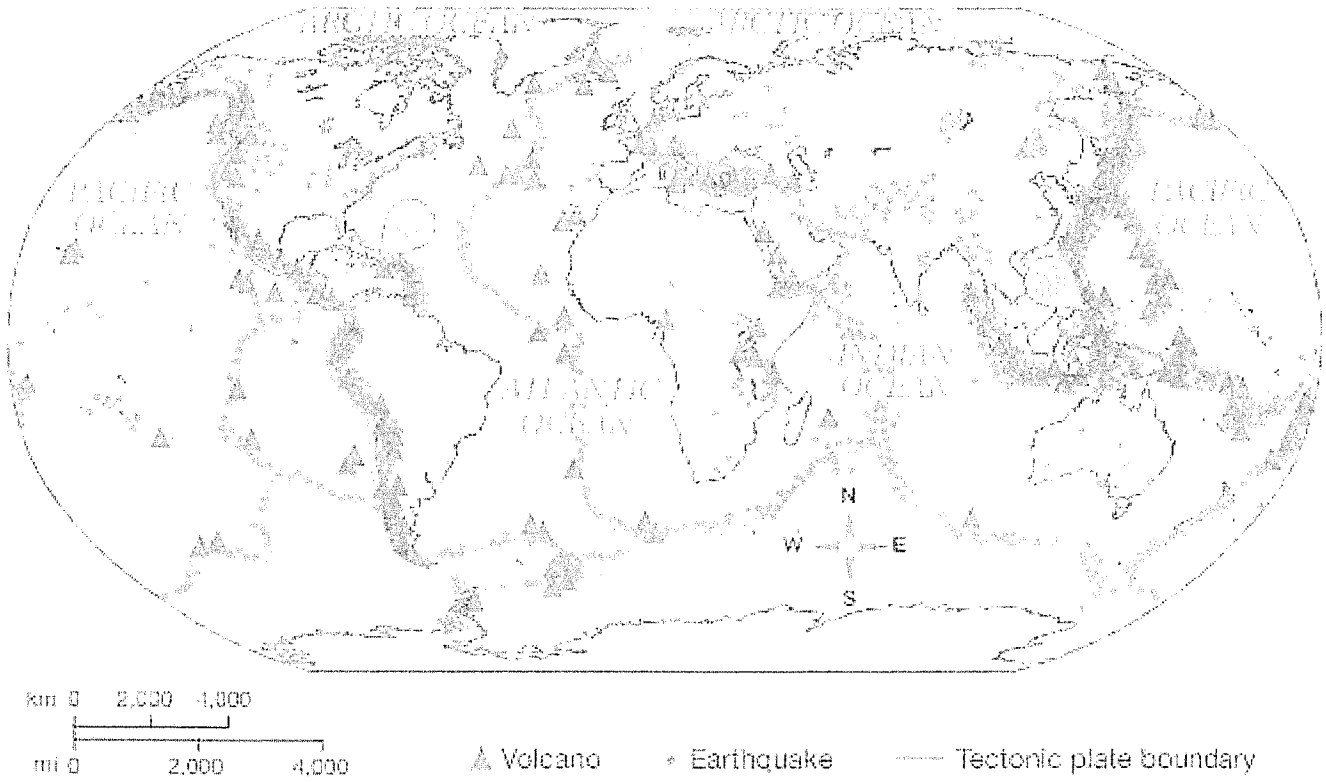


Scientists use technology to monitor conditions that relate to the occurrence of natural hazards. For example, satellites orbit Earth and collect weather data. These data go into computer models that help scientists predict weather-related hazards. For hazards that are likely to occur in specific locations, monitoring technology may be designed for and placed in those areas. For example, underwater earthquakes, landslides, and volcanic eruptions can be precursor events to tsunamis. So, scientists monitor ocean water movement after those events in order to predict tsunamis. Tsunami sensors might be put on buoys or on the sea floor to detect water movement in areas at high risk of tsunamis.

24 Predicting Geologic Hazards

Geologic hazards include volcanoes, earthquakes, tsunamis, sinkholes, and landslides. Different areas experience different geologic hazards. For example, areas near tectonic plate boundaries experience more earthquakes than areas far from plate boundaries. The likelihood of a geologic hazard occurring in a specific location can be determined. But the timing and magnitude of geologic hazards are difficult to predict.

Worldwide distribution of Earthquakes and Volcanoes



In 2010, a major earthquake shook the ground and toppled buildings in Haiti. Earthquakes happen suddenly and currently cannot be predicted.

Scientists predicted the eruption of Mount Pinatubo in 1991. The predictions helped thousands of people evacuate before falling ash and lahars destroyed villages.

Predictions of Volcanic eruptions 25

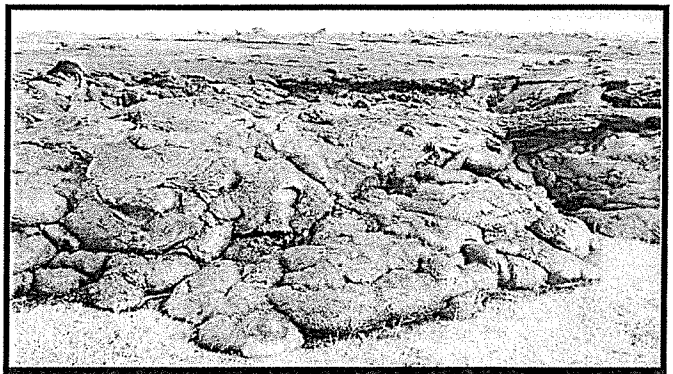
Predictions of volcanic eruptions usually include the likelihood of an eruption within a given time frame. They might also identify possible hazardous effects or related hazards, such as lava flows or wildfires. To determine the likelihood of a volcanic eruption, scientists analyze data, such as the locations of active volcanoes or a certain volcano's past eruptions. Eruption predictions are not always certain because most volcanoes do not erupt on regular schedules.

Scientists study the causes and effects of volcanic eruptions. Scientists know that before an eruption, molten rock in Earth's interior, called *magma,* moves closer to the surface. The movement of the magma cracks the surrounding rock and causes swarms of small earthquakes. The moving magma also releases gases into the air and causes the ground surface to change shape. Scientists study volcanoes to determine whether a volcano is active. They also see whether an eruption could result in a natural disaster.

Data from Past Eruptions

Past eruption data for a volcano can include eruption timing, precursor events, and eruption types. For example, volcanic rocks and ash layers from past eruptions can tell how often and how explosively a volcano has erupted in the past. This helps scientists determine whether a volcano is active and what type of eruption, if any, is likely to happen in the future. For example, a volcano that explosively erupted and made large amounts of ash in the past most likely will have a similar eruption in the future.

Mauna Loa is an active volcano located on the Big Island of Hawaii. It is a shield volcano. This means that it is a broad dome with gently sloping sides. Shield volcanoes often have steady lava flows rather than explosive eruptions. Many eruptions of Mauna Loa have been witnessed by people living in Hawaii. For safety, scientists monitor many active volcanoes near populated areas.



Mauna Loa Eruption Data 1832 - 2004

Location: Mauna Loa, Hawaii	1832, 1843, 1849, 1851, 1852, 1855–1856, 1859, 1865–1866, 1870 (?)*, 1871, 1872, 1873, 1873–1874, 1875, 1876, 1877, 1879, 1880, 1880–1881, 1887, 1892, 1896, 1899, 1903, 1907, 1914–1915, 1916, 1919, 1926, 1933, 1935–1936, 1940, 1950, 1975, 1984
Type and Elevation: Shield volcano, 4,170 m (13,681 ft)	
Eruption Style: Nonexplosive, with steady lava flows	

*The question mark indicates that the exact year of the eruption is not known.

Source: USGS, Hawaii Volcano Observatory, "Summary of Historical Eruptions, 1843–Present", 2004

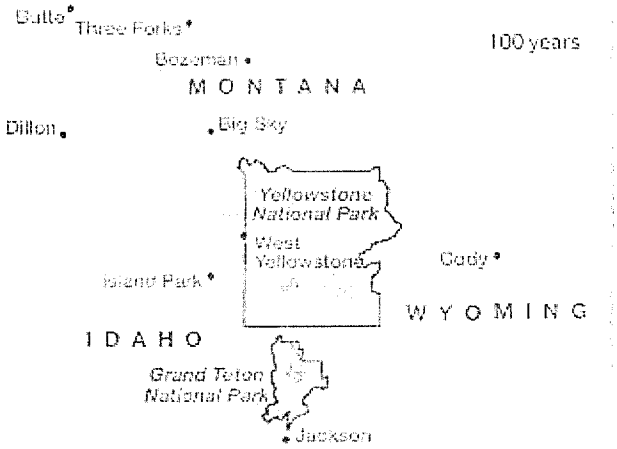
Mauna Loa erupted on average once every four years between 1832 and 1984. From 1870 to 1880, the number of eruptions was **greater / fewer** than average. Beginning in 1940, eruptions were **more / less** frequent than average.

26 Earthquake Prediction

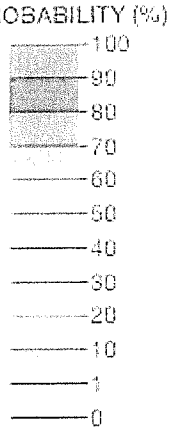
Earthquakes can become natural disasters because the shaking can damage structures. Earthquakes can also cause tsunamis, fires, and landslides. Scientists are able to identify areas where earthquakes are likely to happen and cause damage. But they can't predict the timing of an earthquake. Scientists use historical data, seismograph data, and GPS data to make earthquake risk maps.

Probability of a Magnitude 7.0 Eathquake Near Yellowstone National Park

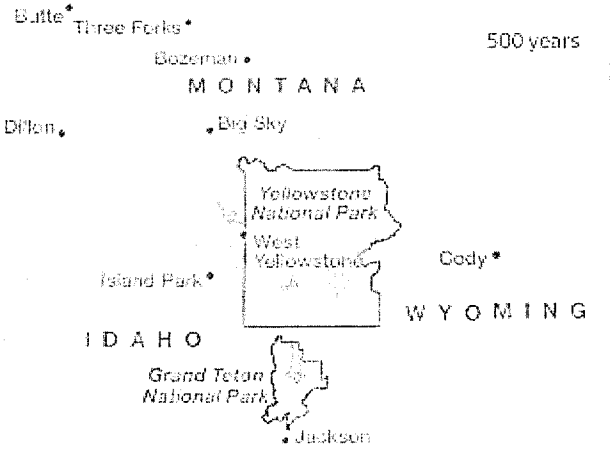
A magnitude 7.0 earthquake is a large earthquake that could cause major damage, injury, or death.



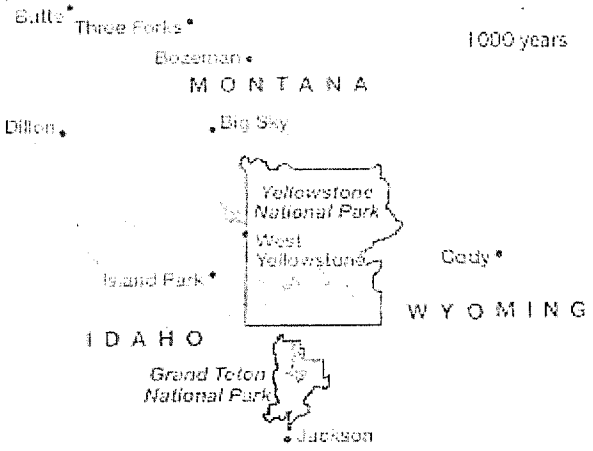
Probability of a 7.0 earthquake within the next 100 years.



Source: USGS, Geologic Hazards Science Center, National Seismic Hazard Mapping Project, 2008



Probability of a 7.0 earthquake within the next 500 years.



Probability of a 7.0 earthquake within the next 1,000 years.

Analyzing Data

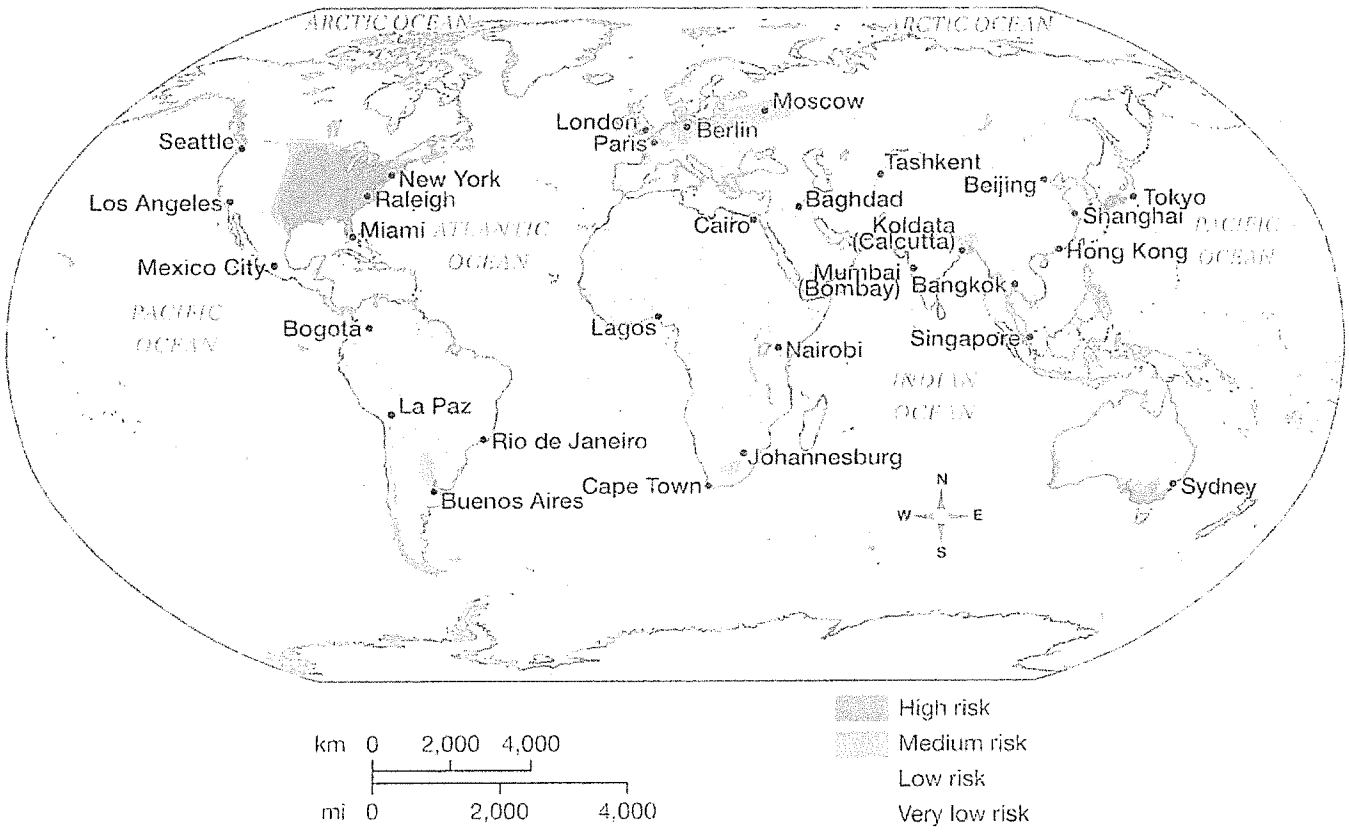
What is the probability of a magnitude 7.0 earthquake happening in Bozeman, Montana in the next 100 years? **0 – 1%, 1 – 10%, 10 - 20 %**

Choose Big Sky, Island Park, or Jackson. Use the key to explain how the chance of a magnitude 7.0 earthquake relates to the length of time for which the projection is made for the town you have chosen.

Predictions of Weather Hazards 27

Weather hazards include thunderstorms, snowstorms, tornadoes, and floods. These hazards occur in locations where the atmosphere, ocean, and land interact to create specific conditions. A weather-hazard prediction indicates when and where dangerous weather conditions are likely to develop. Warnings about weather hazards are issued only minutes to days before a potential event. *Climate hazards* are large-scale phenomena that are related to long-term weather patterns. Climate hazards include droughts, sea-level changes, and wildfires.

Worldwide Tornado Risk



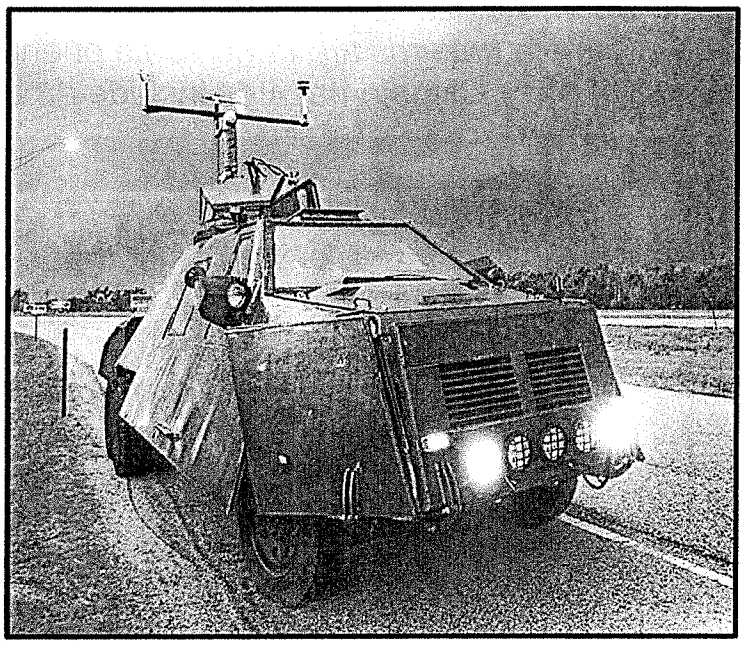
Look at the map and the photo. We know where tornado risk is high, but do you think we can prevent tornadoes from causing damage and injury? Explain.

In 2011, a tornado destroyed this house in North Carolina. A tornado warning was issued about 24 minutes before the tornado struck the area.

28 Predicting Tornadoes

Tornadoes are rapidly spinning columns of air that extend from storm clouds to the ground. Their winds can travel at almost 500 kilometers per hour. They can destroy neighborhoods or entire towns in seconds, sometimes causing fatalities. Tornadoes are difficult to predict with any certainty. Thus, tornado forecasts are usually made for large areas and do not specify exact timing.

However, predictions of actual tornado events can be made only minutes or seconds before a tornado strikes. Agencies such as the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS) collect weather data that are used by meteorologists to predict tornadoes. Data are collected by weather satellites, weather stations, and weather balloons and from reports from trained weather observers. Data are used in computer models to determine whether tornadoes are likely to form in specific conditions.



Historical Data

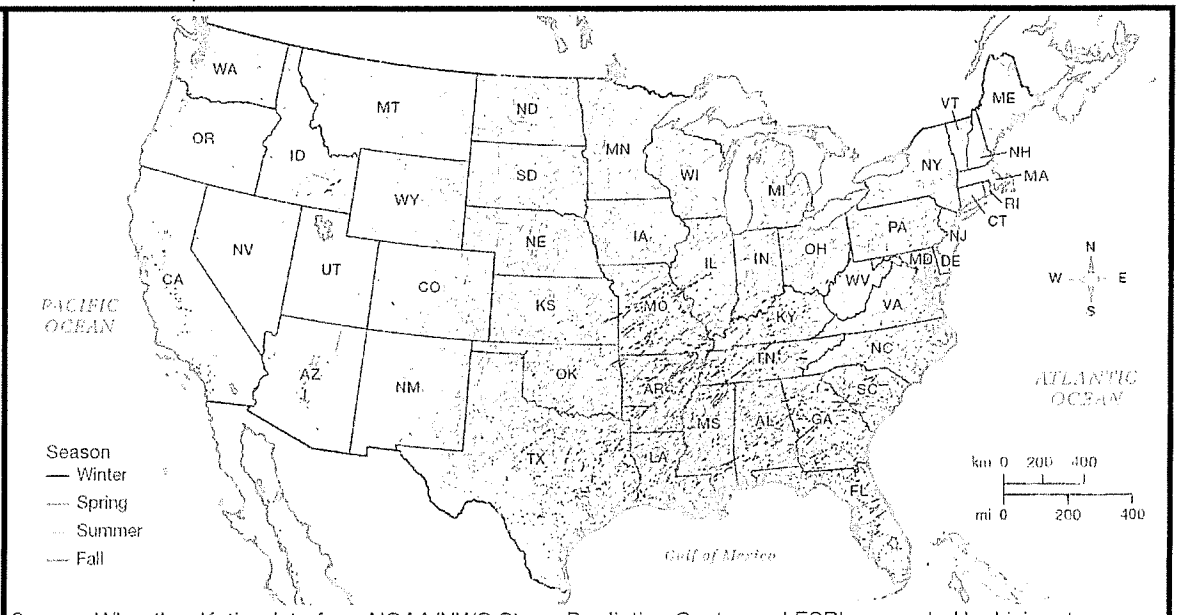
Meteorologists analyze historical data to determine when tornadoes are most common. In the United States, tornadoes tend to strike during late afternoons and evenings in the spring and summer months. However, tornadoes have struck in the morning and in winter. Scientists analyze historical data, such as the map of tornado tracks in the United States, to determine where tornadoes are most common.

The tornado data on this map show a pattern. In the northernmost states where tornadoes occur, most tornadoes occur in the

_____

In the southeastern United States, most tornadoes occur in the

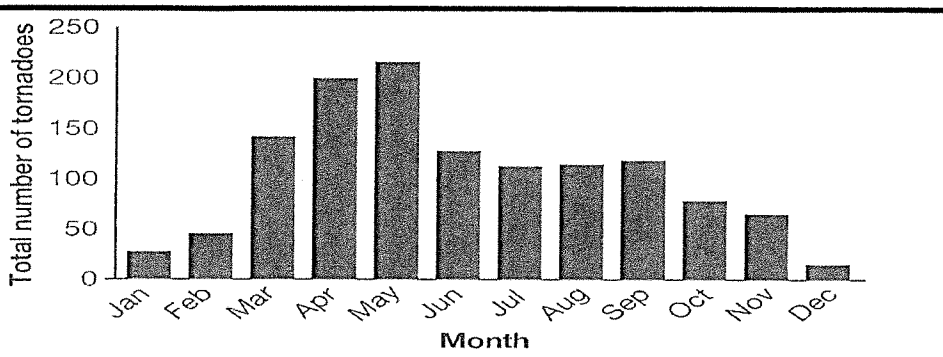
_____



Source: Wheatley, Katie, data from NOAA/NWS Storm Prediction Center and ESRI, as quoted by Livingston, Ian. 2013, "Monthly tornado averages by state and region," U.S. Tornadoes

Tornado Prediction

29



Source: State Climate Office of North Carolina, Tornadoes by the Numbers, 1950–2015

Analyzing Data

These historical data show that tornadoes are **least** likely to occur in North Carolina in _____.

These historical data show that tornadoes are **most** likely to occur in North Carolina in _____.

Monitoring

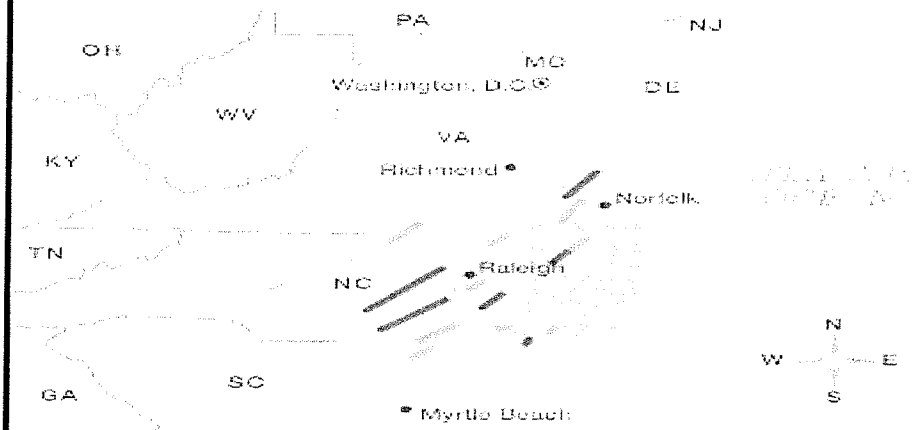
Weather conditions are monitored during supercell thunderstorms to determine the likelihood of a tornado. This table and map were made from weather monitoring data. The data were gathered before and during a tornado outbreak in Raleigh, North Carolina and the surrounding region in 2011.

Weather Forecasts for Raleigh, NC, from April 12 to April 16, 2011

April 12, 2011	Forecast mentions a likely threat of upcoming severe weather on the evening of April 15th.
April 13, 2011	Forecast of severe weather is shifted to the daytime of April 16th.
April 14, 2011	NWS issues a prediction of a 30% chance of a major severe weather event on the 16th.
April 15, 2011	The likelihood of a severe weather event is increased to 45% and tornadoes are deemed "likely" to occur.
April 16, 2011	In the morning, NWS issues a warning for afternoon severe thunderstorms and tornadoes. In the afternoon, more than 30 tornadoes strike. Tornado warnings are issued for specific areas an average of 20–30 minutes before the tornadoes strike.

NOAA Storm Prediction Center Outlook and Confirmed Tornado Tracks

In the late afternoon on April 15th, 2011, several tornadoes were confirmed and a prediction of more tornadoes was issued.



Enhanced Fujita Scale

0 1 2 3

Storm Prediction Center Outlook

Slight: Scattered severe storms possible; 1 or 2 tornadoes.

Moderate: Widespread severe storms likely; strong tornadoes.

High: Widespread severe storms expected; tornado outbreak.

km 0 100 200

mi 0 100 200

Source: Kathryn Prociv, "North Carolina's Largest Tornado Outbreak—April 16, 2011," 2013

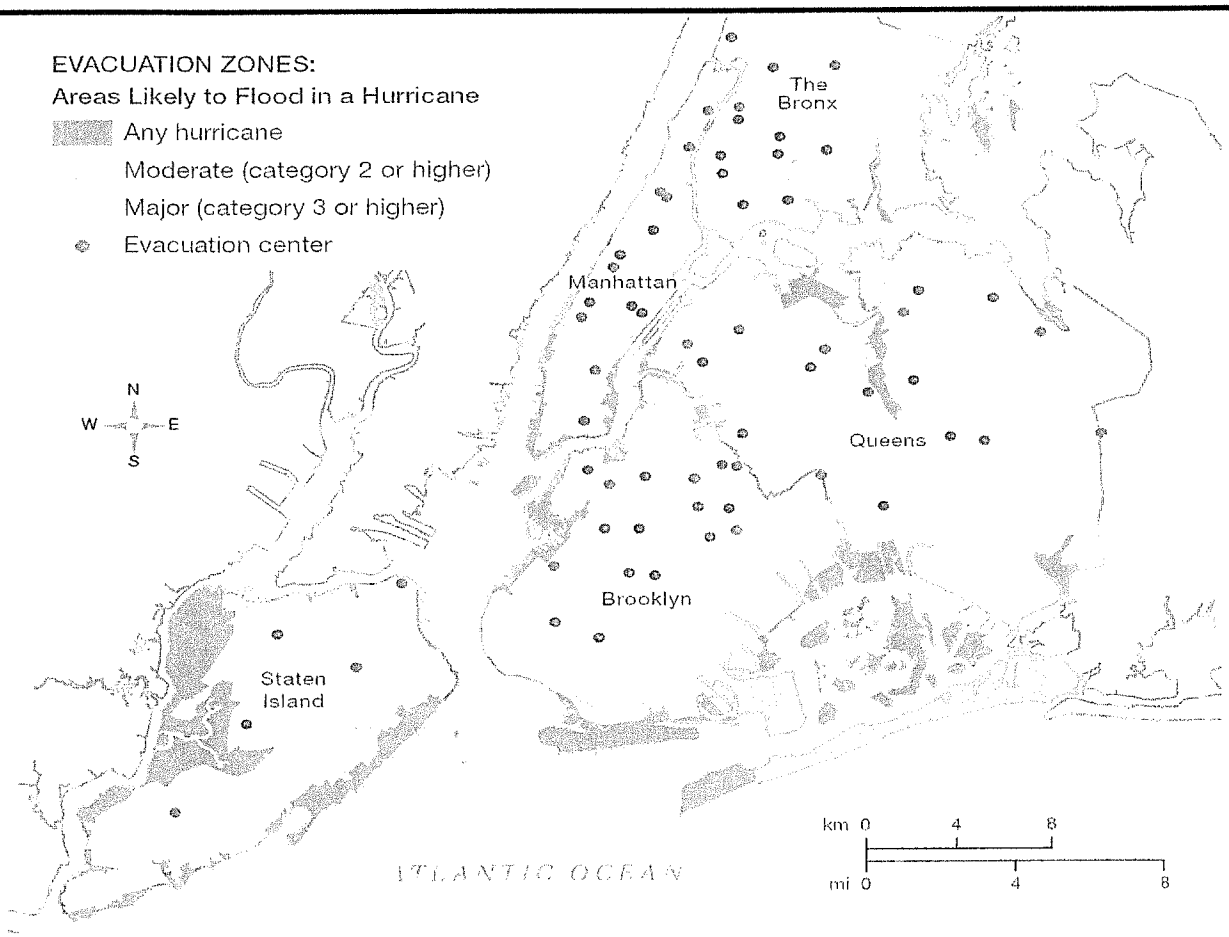
How did the information available in the weather forecasts change in the days leading up to April 16th? Do you think these forecasts gave people enough time to prepare for the tornadoes? Explain.

30 Predicting Floods

Natural hazards such as thunderstorms and hurricanes can cause flooding. Flooding happens when land that is normally dry is covered by water.

Using Flood Maps

Historical data are used to create flood-risk maps to show how likely areas are to flood under certain conditions. When locations that can flood are identified, the effect of the floods on people can be predicted. It is important that people know safe routes to get out of flood-prone areas. Evacuation routes connect evacuation zones, or areas to be evacuated, to evacuation centers, where people can go to be safe during a flood event.



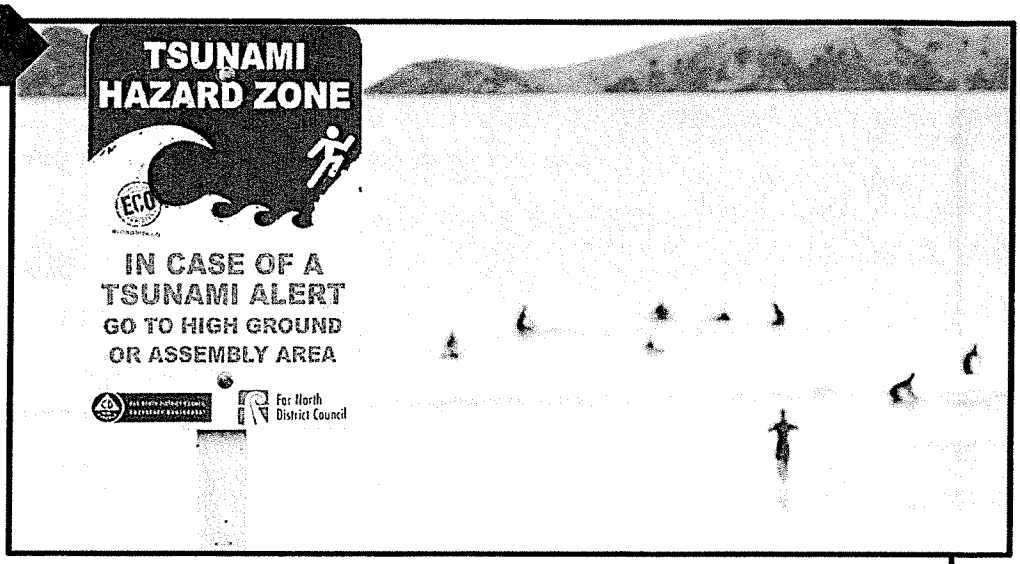
Source: New York City Office of Emergency Management, as quoted by The New York Times, "New York City Hurricane Evacuation Zones," August 26, 2011

A moderate hurricane in the Atlantic Ocean is heading toward New York City. Based on the map, identify the areas that have a high chance of flooding during and after this storm. Suggest which areas people should evacuate based on the coming storm and support your claim with evidence and reasoning.

Revisiting the Phenomena 31

Can You Explain It?

This beach on the east coast of New Zealand is a popular recreation spot. Some coastal areas are at a higher risk for tsunamis than others are. Use your knowledge of natural hazards and what you have recently learned to answer the questions below.



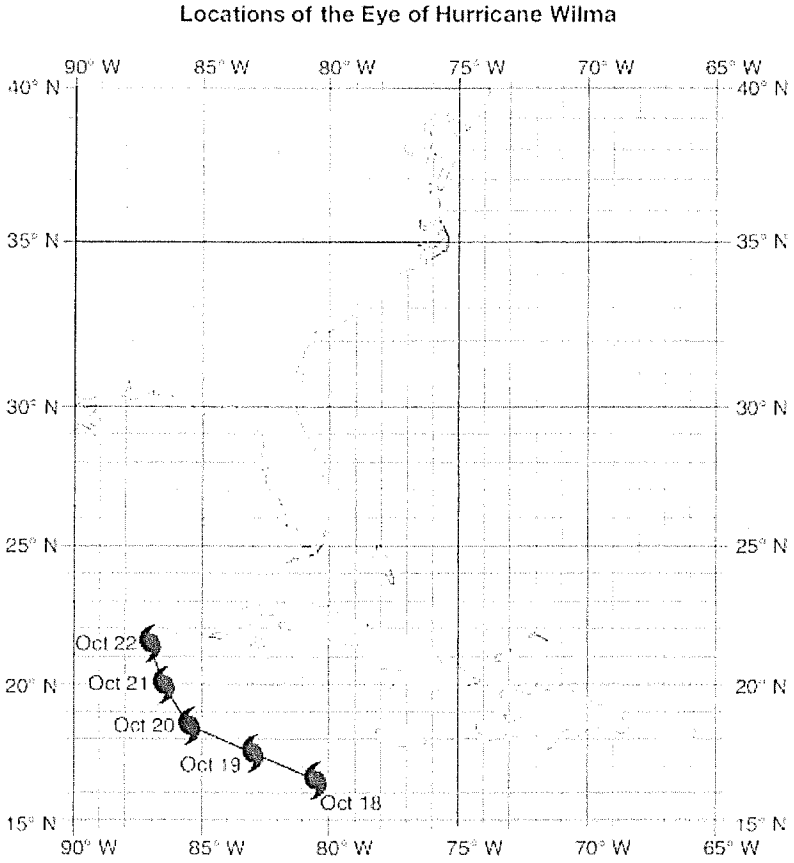
Why is there a tsunami hazard warning sign on this calm beach?

1. State your claim. Make sure your claim fully explains why there is a tsunami hazard warning sign on a calm beach.

2. Summarize the evidence you have gathered to support your claim and explain your reasoning.

Natural Hazards Review Sheet

Hurricanes:



1. Plot the path of the hurricane on the map to the left using the data table below.

Oct 23	22.5° N	86 ° W
Oct 24	27° N	80 ° W
Oct 25	38.5° N	66 ° W
Oct 26	21.5° N	87 ° W

2. What types of damage are caused by hurricanes?

3. What can you do to prepare for a hurricane? Discuss three things

Tornadoes

1. What area of the country is most likely to experience a tornado?

2. What types of damage are caused by a tornado?

3. Scientists monitor air pressure to help predict which two types of natural disasters?

Natural Hazards Review Sheet

Earthquakes

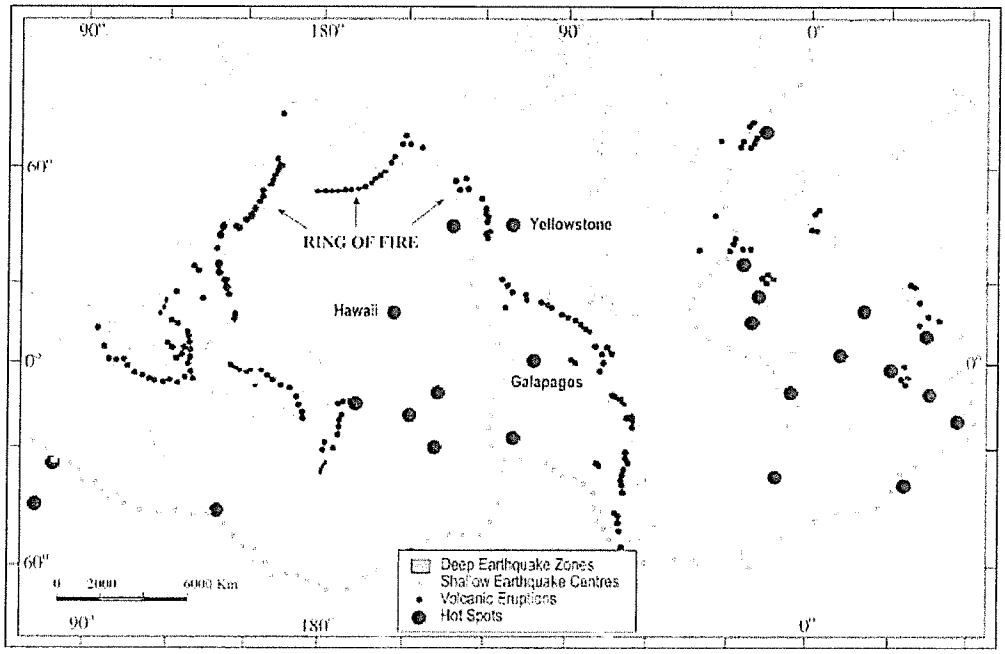


Figure 4. 2 : Distribution of earthquakes and volcanoes

1. Where are earthquakes and volcanoes most likely to occur?

2. Why do they occur in these areas?

3. What type of damage is caused by earthquakes?

Tsunami

1. What is the cause of a tsunami?

2. What type of damage can be caused by a tsunami?

Natural Hazards Review Sheet

Volcano

1. Dust and ash from a volcanic eruption can block sunlight. How does this affect Earth's Weather and Climate?

2. What can a volcano release when it erupts?

3. Scientists monitor the following ...

Clues Used to Determine a Potential Volcanic Eruption

Seismic activity	Seismographs can determine if earthquakes are coming closer to the surface which might indicate magma movement.
Ground deformation	Small parts of land surrounding a volcano can start to push up or apart.
Water temperature	Water temperatures may increase as a result of magma movement in local groundwater or in nearby springs.
Gas monitoring	Gas can creep out of the ground surrounding a volcano or seep into hot springs.

How does this monitoring help scientists?