EARTH SCIENCE

for Young Catholics

SETON PRESS

Earth Science
for Young Catholics

Seton Press
Front Royal, VA

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Printed in the United States of America

Seton Press
1350 Progress Drive
Front Royal, VA 22630
Phone: (540) 636-9990

ISBN: 978-1-60704-177-1

For more information, visit us on the web at www.setonpress.com
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Earth Science for Young Catholics

INTRODUCTION

Welcome to *Earth Science for Young Catholics*. This worktext was written *by* Catholics *for* Catholic homeschooled students. It focuses on the created universe, most especially, our own planet Earth.

Many of the concepts, and much of the information, in this book will be new and more in-depth than a student is accustomed to. Every effort has been made to keep material approachable in an age-appropriate way. You will find yourself asking, "Didn't we study this already?" The answer is, "Yes." Repetition is the key to learning and makes what may seem difficult at first become familiar and, perhaps, even easy. Pay special attention to vocabulary. Science has its own language. Beginning to master this language now will be a tremendous help in future science study.

Each chapter consists of five lessons. Lessons one through four contain the content for the week's concepts and information. Special attention was given to keeping these lesson uniform in length, so parents and students know how much time needs to be allocated daily. Each lesson has a short "review." There are no "trick" questions. Most are taken directly from the text—many word for word. Students should be able to complete the review with little or no help from the teaching parent.

Lesson five is meant to be more relaxed. The written portion is about half the length of the other days and the content is intended to be high interest. Sometimes, Lesson five will tie topics to our Catholic faith. (Did you know seismology was known as the "Jesuit Science"? Should we be concerned about overpopulation?) Other times, it may address topics that are less religious, but hopefully every bit as interesting. (Why is the International Date Line crooked? Why are weathermen called meteorologists?) Enrolled Seton Home Study students will <u>not</u> be tested on lesson five text, but should enjoy reading it.

Lesson five also includes a chapter review of the week's work and a cumulative review that includes material from previous chapters. Each teaching parent must decide how much review is appropriate for an individual student, hopefully remembering that, "Repetition is the key to learning." Enrolled Seton students <u>will</u> be tested on this information.

Every effort has been made to fill this book with colorful graphics that aid understanding. We encourage you to look up additional resources online. Enrolled students will find suggestions in their lesson plans.

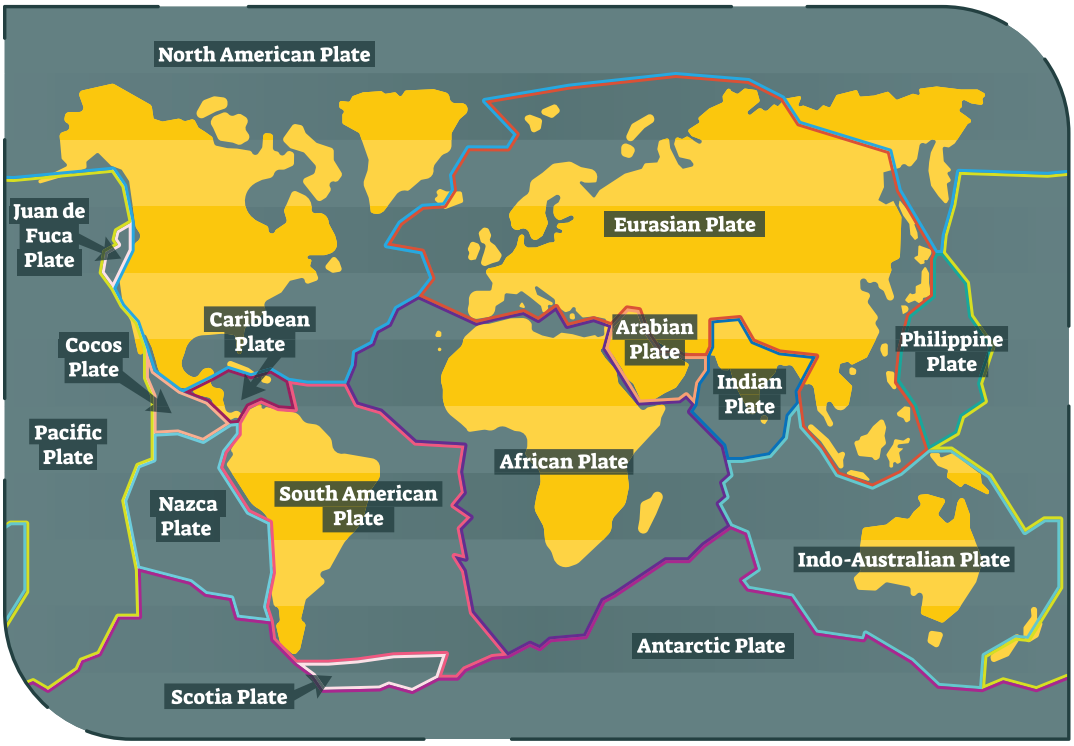
CHAPTER 16
EXTREME NATURAL EVENTS

16.1 EARTHQUAKES

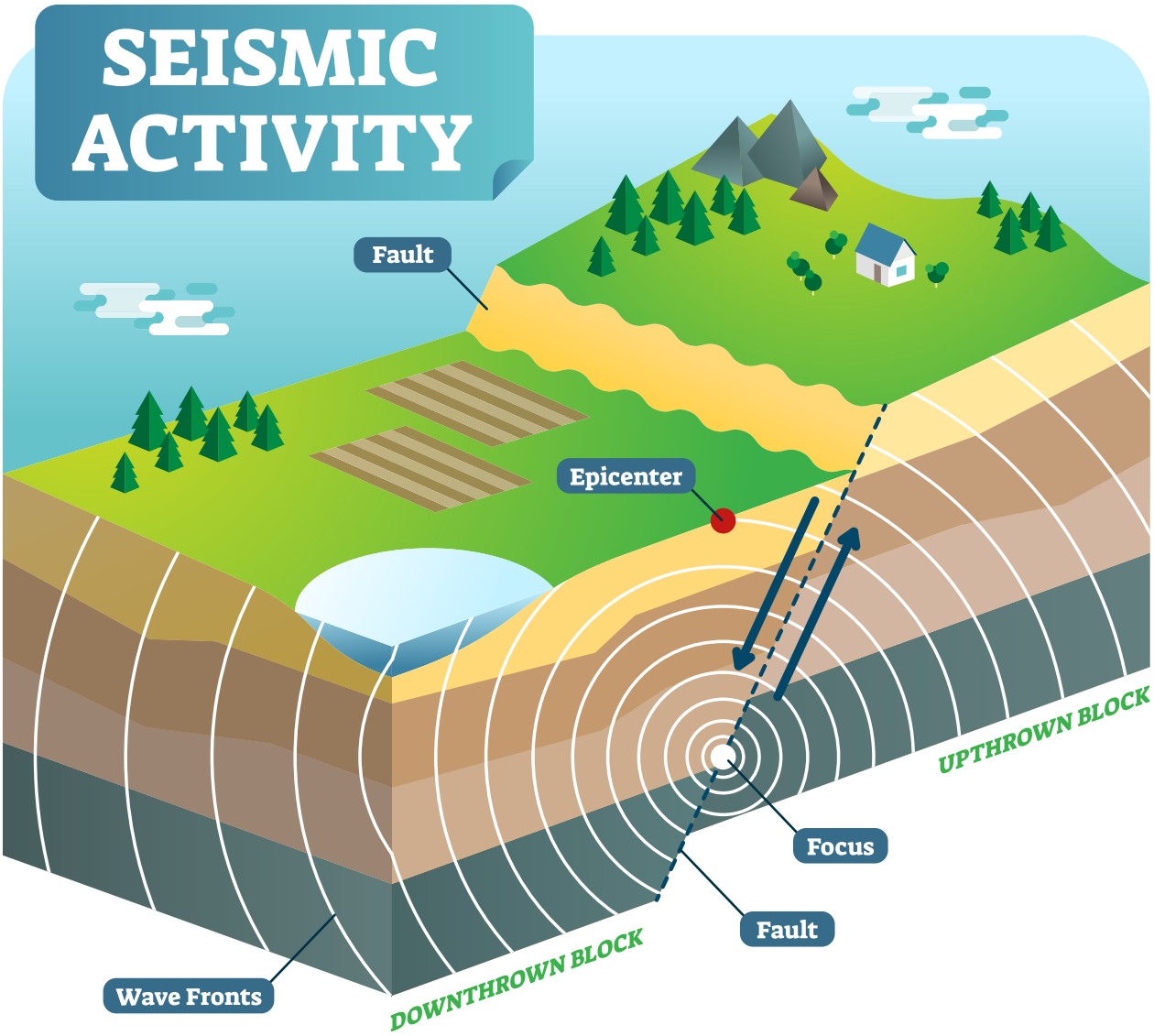
Plate Tectonics

In Chapter 3, Lesson 4, you learned about the Theory of Plate Tectonics. You learned that **tectonic plates** are immense slabs of rock that make up the **lithosphere** (the Earth's hard outer crust). These plates are in constant motion on the Earth's more fluid mantle, although the movement is quite slow. The line along which two tectonic plates meet is called a **fault**. For example, two immense plates, the North American Plate and the Pacific Plate, meet along the California coastline. This boundary is called the **San Andreas Fault**.

The Pacific Plate moves in a northwest direction toward the North American Plate at a rate of about 5 centimeters (2 inches) per year. Friction stress accumulates at the fault boundary, but can be relieved by tiny slipping called **creep**. At times, there are tiny shocks and Earth **tremors** (shaking in the Earth's crust) in areas with constant creep. Many times, these tremors are too weak to be felt, but can be detected by vibrations in the Earth's crust on a seismograph.



Tectonic Plates



How Does an Earthquake Occur?

In some areas, there is no creep to make tremors less severe. Edges of one plate cease to move, but the other plate keeps applying pressure. Stress builds on the fault line and eventually, perhaps only after many years, the plates move suddenly. This sudden movement along the fault line produces an earthquake. In addition to earthquakes caused by shifting tectonic plates, earthquakes can also be produced by volcanic activity.

An **earthquake** is a sudden and violent shaking of the ground, sometimes causing great destruction.

Anatomy of an Earthquake

As stress builds along a fault line, there are frequently, although not always, foreshocks. **Foreshocks** are tremors that occur before the larger one. Seismologists cannot determine whether a minor earthquake is a foreshock, or the only shock, until after a more powerful earthquake occurs. The larger, most powerful movement is called the **mainshock**. There are always less powerful **aftershocks** following a mainshock.

The area below the Earth's surface where the earthquake originates is called the **hypocenter**. The location directly above the hypocenter, at the Earth's surface, is called the **epicenter**.

How Is the Intensity of an Earthquake Measured?

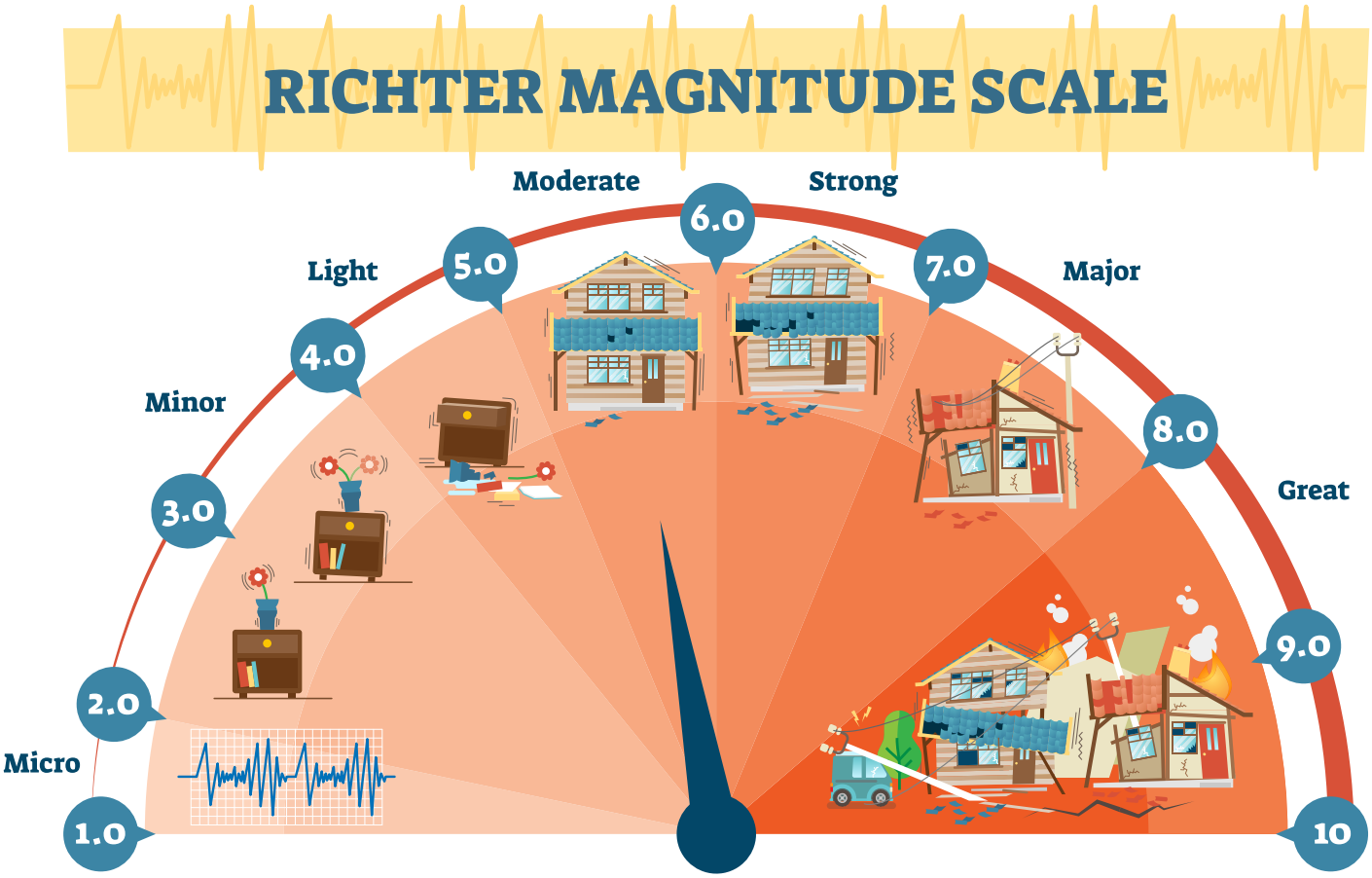
Scientists use two words to measure earthquakes. The **intensity** describes how severe the shaking is. The **magnitude** of an earthquake describes how far-reaching it is—its size.

In Chapter 5, Lesson 5, you learned a bit about Giuseppe Mercalli. He developed a method to measure earthquake intensity. The **Mercalli scale** uses the observation of witnesses as well as damage to various structures to measure the strength of the earthquake.

More commonly we hear newscasters speak of the Richter scale when reporting on earthquakes. The **Richter scale** was developed by Charles Richter in the mid-1930s. It measures earthquake magnitude based on seismograph readings and the distance of the seismometer from the epicenter of the quake.

Charles Richter

Although widely used, the Richter scale was not able to provide accurate information about the highest magnitude earthquakes. Scientists today use the **moment magnitude scale (Mw)**. This scale works over a wider range of earthquakes.



16.1 LESSON REVIEW

A. Tectonic plates
B. Lithosphere
C. Fault
D. Creep
E. Tremors
F. Foreshocks
G. Mainshock
H. Aftershocks
I. Intensity
J. Magnitude
K. Earthquake
L. Richter scale
M. Moment magnitude scale (Mw)
N. Epicenter

Write the letter next to each word on the line with its definition below.

1. _____ Measures earthquake magnitude based on seismograph readings and the distance of the seismometer from the epicenter of the quake.
2. _____ Measures how far-reaching an earthquake is.
3. _____ The line along which two tectonic plates meet.
4. _____ Shaking in the Earth's crust.
5. _____ A sudden and violent shaking of the ground, sometimes causing great destruction, as a result of movements within the Earth's crust or volcanic action.
6. _____ Describes how severe the earthquake's shaking was.
7. _____ Immense slabs of rocks that make up the lithosphere.
8. _____ Location directly above the hypocenter, at the Earth's surface.
9. _____ The Earth's hard outer crust.
10. _____ Able to provide accurate information about the highest magnitude earthquakes.
11. _____ Less powerful tremors following a mainshock.
12. _____ Movement at the fault line that can make tremors less severe.
13. _____ Tremors that occur before a larger earthquake.
14. _____ Largest, most powerful movement.

16.2 TSUNAMI

The shaking of an earthquake can cause an immense amount of damage and devastation. At times it causes even greater destruction by creating a tsunami. A **tsunami** is a giant wave. The vast majority of tsunamis, 88%, are caused by earthquakes, or landslides created by earthquakes, under the ocean. Others can be caused by volcanic activity. Scientists believe that falling heavenly bodies, including asteroids and meteorites, have created tsunamis in the Earth's past.

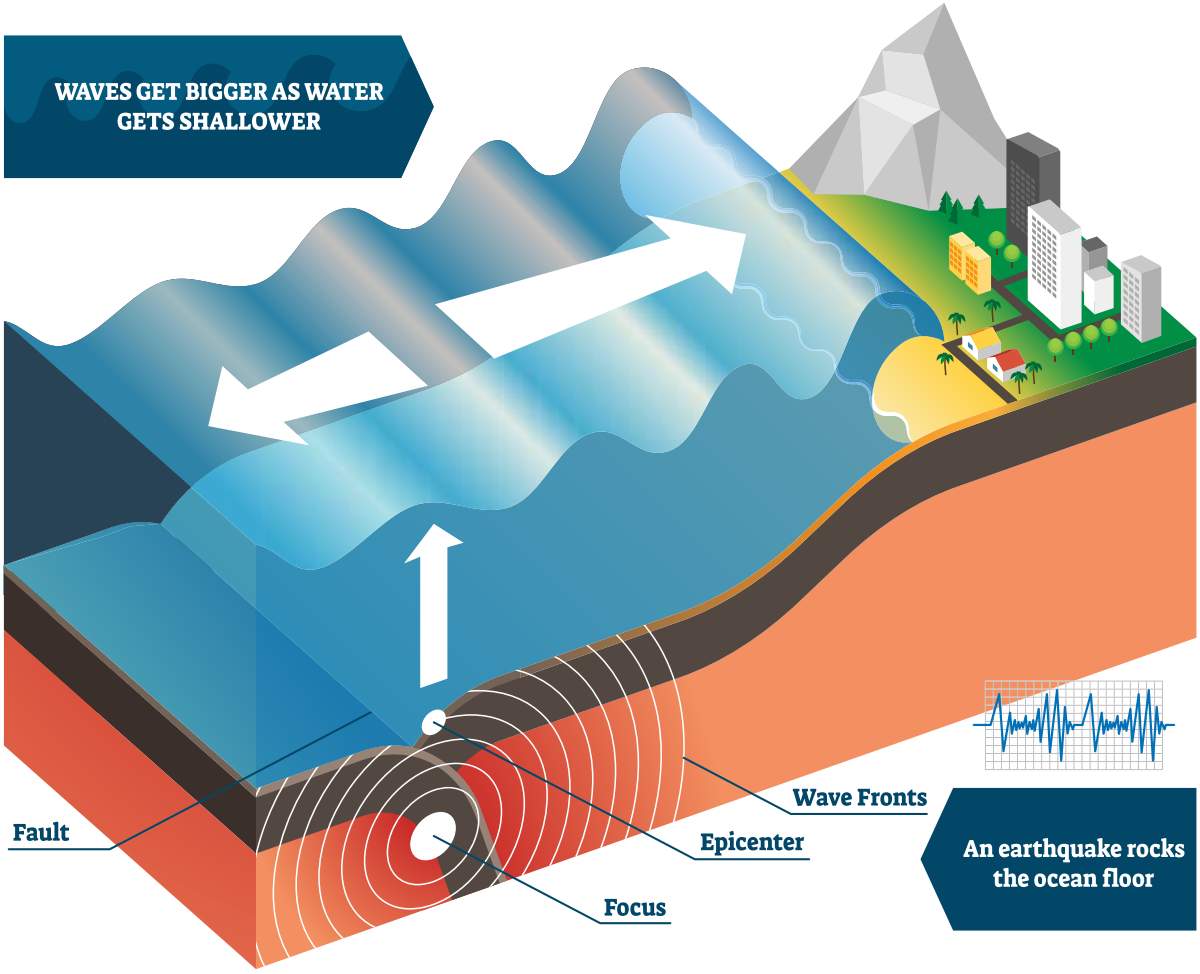
Tōhoku Tsunami, Japan 2011

What Triggers a Tsunami?

Have you ever thrown a rock into a lake or pool? The rock splashes into the water and creates a

A Tsunami Sign

TSUNAMI



series of ripples that radiate out in all directions. Tsunamis occur when a sudden movement of the ocean's floor moves water and creates waves. These waves race across the ocean, sometimes in the deepest water, at the speed of a jet plane. The waves, relative to the ocean depth, may not be very high, but as they approach land, the ocean gets shallower. The waves do not taper off, but keep the height they have in the deep ocean. Typically, a tsunami is a series of extremely long waves, with tens to hundreds of miles between them. This is sometimes referred to as a **tsunami wave train**.

What Happens When a Tsunami Hits the Coast?

You may have seen ocean waves, or certainly seen videos of them. Typically, an ocean wave swells, that is, it gets taller and taller until the wave breaks and crashes onto the land.

A tsunami does not break and crash. The waves do not grow higher. As the ocean floor becomes shallower, the waves remain as high as they were in the deep sea. They can be as high as 30 meters (100 feet) on the shoreline. Over the deep ocean, tsunamis travel at speed of up to 695 kilometers

(600 miles) per hour. Each one slows down as it approaches the coastline. Now they are no longer as fast as a jet plane. They travel more like a car coasting along at 32 to 48 kilometers (20 to 30 miles) per hour.

Generally, the first wave to reach the coast is not the strongest one. The giant wave hits the shore like a wall of water. How strong is it? If you had a container that was one cubic meter, that is 1 m high, 1 m wide, and 1 m deep, it would weigh about 1000 kilograms or 1 metric ton (a little over 2200 pounds).

An amount of water, not as wide, high, and deep as your arms spread out, would weigh 1000kg, and it would be traveling as fast as a car cruises through a city street. Of course, there is not just 1 metric ton but thousands and thousands of them pounding the coast line. The powerful water picks up boats, cars, and trucks. Whole buildings are swept away. The ocean water becomes filthy with debris, and even more dangerous as it sweeps these heavy objects into one another and into people and objects in its path. Tsunamis are terribly destructive. In 2004, a tsunami in the Indian Ocean hit eleven countries and killed over a quarter of a million people.

A tsunami can push water and debris many miles inland. However, once the wave hits land, it loses its energy.

Damage After a Tsunami

16.2 LESSON REVIEW

Choose the correct answer to each question.

1. _____ Tsunamis can be caused by

a. earthquakes
b. landslide resulting from earthquakes
c. volcanic activity
d. All of the above

2. _____ In deep waters, tsunami move across the ocean at the speed of a

a. jet plane
b. race car
c. family automobile
d. bicycle

3. _____ As waves approach the coast line, they

a. speed up
b. slow down
c. remain at the same speed
d. sometimes speed up; other times slow down

4. _____ As it approaches the coastline, the tsunami

a. gets higher
b. loses height
c. remains the same, but the ocean floor get shallower
d. sometimes gets higher; other times loses height

5. _____ As it approaches the coastline, the tsunami

a. appears as a wall of water
b. crests and breaks like all ocean waves
c. recedes back into the ocean before it hits the beach
d. gains more strength

Use words from this lesson to fill in the blanks.

6. How much does 1 metric ton of water weigh?

_____ kilograms _____ pounds

7. List some of the destruction caused by tsunamis.

_____

_____

_____

16.3 VOLCANOS

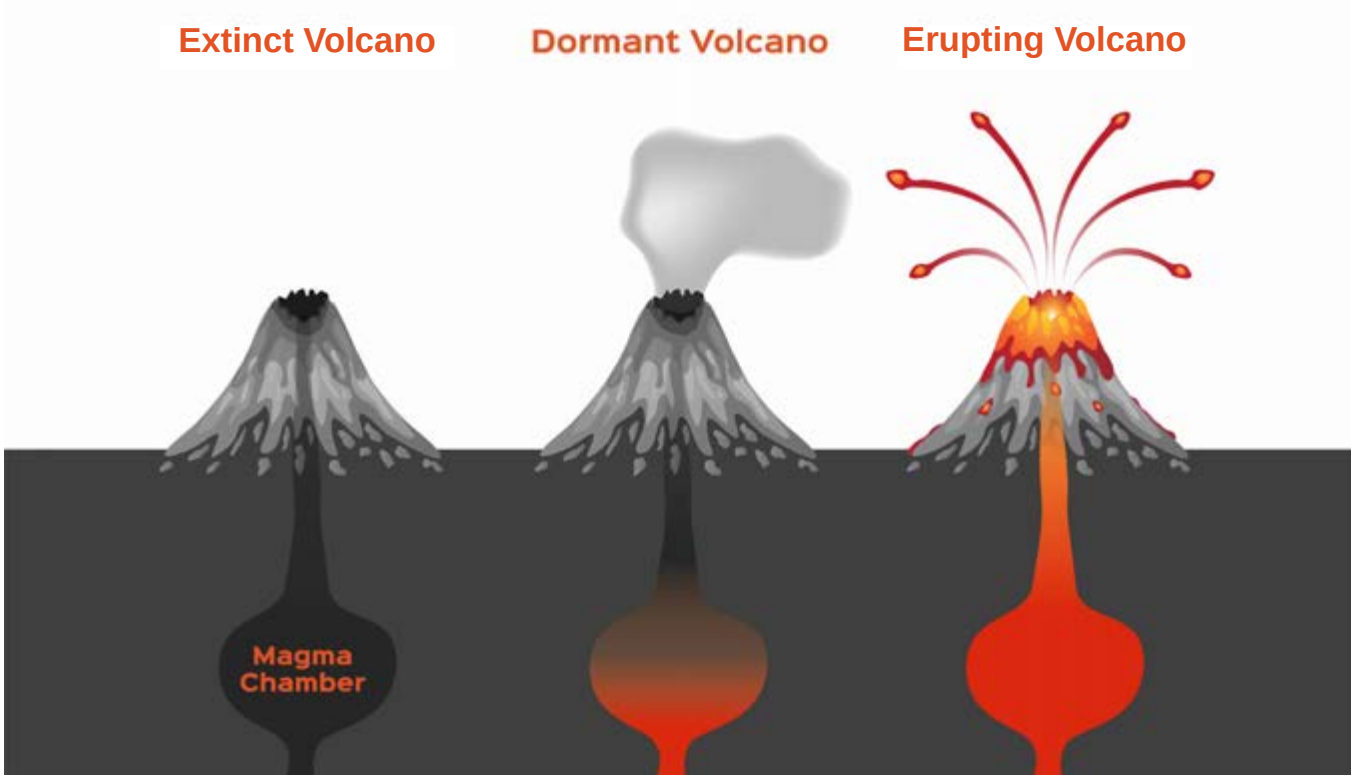
You have learned that an **extreme natural event** is a change in the Earth's environment that can cause tremendous loss of human life and destruction to property. Generally, these changes are not long in duration, but often have long-lasting consequences.

Volcanic Eruption

In Chapter 5, you learned that a **volcano** is a mountain built up around a vent in the Earth's crust. Rocks inside the Earth melt into a thick liquid called **magma**. As magma is lighter than solid rock, it rises and collects in **magma chambers** under the Earth's surface. Here, the Earth's natural heat creates enough pressure to push magma and gases upward. A **volcanic eruption** occurs when magma (called **lava** once it is on the Earth's surface), ash, rocks, and gases push through vents to the Earth's surface.

Not Every Volcano Will Erupt

It is important to know that not every volcano will erupt. An **extinct volcano** is believed not to have had an eruption in the past 10,000 years and is not expected to have one in the foreseeable future. An **active volcano** has erupted in the last 10,000 years or is expected to erupt soon. An active volcano can be further classified as either dormant or erupting. A **dormant volcano** is an active volcano that is not erupting, but is expected to in the future. Finally, an **erupting volcano** is actively pushing lava, ash, rocks, or gases to the Earth's surface.



Pyroclastic Flow on Mt. Etna in Italy

Pyroclastic Flow

Magma, stored in chambers below the Earth's surface, and now forced upward, flows out of the volcano's vents. Now called **lava**, it is extremely hot, 704˚C to 1,093˚C (1,300˚F up to 2,000˚F), and glows red or white hot as it flows out of vents. As it cools, it turns into **igneous volcanic rock**.

Looking at this picture of an erupting volcano, you mostly see a giant filthy cloud sweeping down the side of the volcano. This mixture of searing hot rock and gases is called **pyroclastic flow**. Pyroclastic flow is hotter than 540˚C (1000˚F) and travels at rates upward of 650 kilometers (400 miles) per hour. It can travel several kilometers away from the volcano, destroying everything in its path. If it melts ice and snow, it can create a lahar.

Lahars

You remember that areas of higher elevation have cooler temperatures. It makes sense, then, that volcanos often have snow, ice, and even glaciers on their slopes. Heat from the eruption and the pyroclastic flow melt the frozen water, which then mixes with rocks and ash from the volcano. This creates a huge, fast-moving mudslide called a **lahar**. The lahar will continue down the mountain into a valley or riverbed at a speed often too fast to allow people to evacuate. In 1985, lahars formed by pyroclastic flow from the Nevado del Ruiz volcano in Colombia killed over 20,000 people in the town of Armero, and thousands more in other nearby towns.

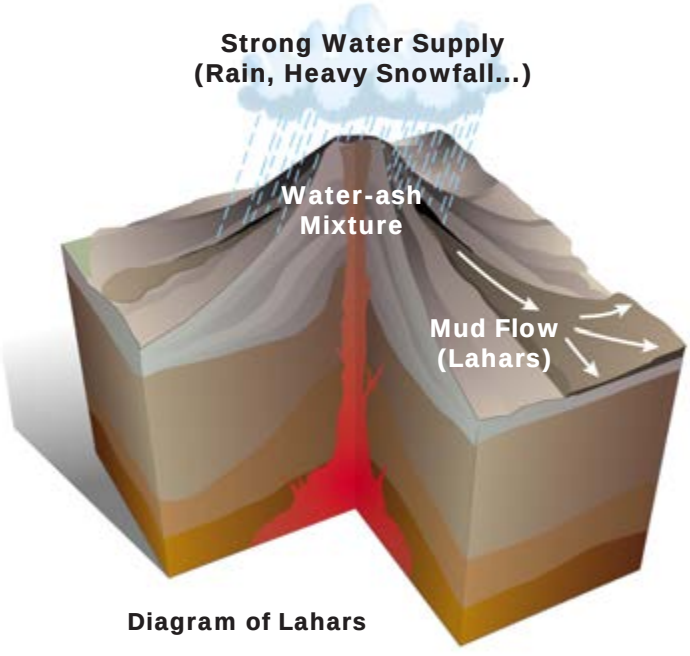


Diagram of Lahars

How Long Does an Eruption Last?

Some volcanic eruptions occur very quickly. Nyiragongo is a steep-sided volcano in the Democratic Republic of the Congo in Africa. On January 10, 1977, the walls of its crater cracked, and the large lake of lava within drained in less than an hour. The lava was very liquid and the volcano's walls were steep, so lava flowed at speeds up to 100 km/h (60 mph). It quickly overwhelmed nearby villages, killing at least 70 people.

On the other hand, some volcanos erupt almost continuously, although not as violently. Mount Yasur in the South Pacific country of Vanuatu has been erupting, often several times an hour, for over a century.

Mt. Yasur, Vanuatu

Mt. Nyiragongo, Africa

16.3 LESSON REVIEW

Evaluate each statement. Print T if the statement is true and F if it is false.

1. _____ All volcanic eruptions are sudden and violent.

2. _____ A dormant volcano is a volcano that is not erupting, and is not expected to in the future.

3. _____ A huge, fast-moving mudslide caused by snow and ice melting from volcanic heat is called a lahar.

4. _____ Molten rock that is still within the Earth's crust is called magma.

5. _____ As lava cools, it turns into sedimentary rock.

6. _____ A volcanic eruption lasts anywhere from less than a day to one week.

7. _____ What appears to be a giant filthy cloud sweeping down the side of the volcano is called a pyroclastic flow.

8. _____ An extinct volcano is believed not to have had an eruption in the past 10,000 years and is not expected to have one in the foreseeable future.

9. _____ An erupting volcano is actively pushing lava, ash, rocks, or gases to the Earth's surface.

10. _____ As magma is lighter than solid rock, it rises and collects in craters under the Earth's surface.

16.4 SAFETY DURING EXTREME WEATHER EVENTS: BE PREPARED!

For the last two chapters we have been studying extreme natural events, changes in the Earth's environment that can cause tremendous loss of human life and destruction to property. Are there steps we can take to protect ourselves during these events? Middle school students are old enough to learn about disaster safety and to talk to parents and other adults about it. Being **knowledgeable** and **prepared** can help keep you and your family safe.

This list of safety rules is far from complete, but perhaps you can talk to your parents about the challenges you may face in the region where you live. (**NOTE**: Many of the tasks recommended are actually meant for parents.)

General Safety Rules

These simple rules apply to virtually all emergency situations.

- Keep a battery-powered portable radio in your home. This radio will allow you to stay updated on the latest information from state and local authorities even when power is out. Some radios now can be operated using solar power or a hand crank.
- Listen to your radio or TV. If you are ordered to **evacuate** (leave your area and go to a safer location), then you should do so as quickly as possible. Do not return until authorities say it is safe to do so.
- Sometimes authorities will tell you it is safest to remain in your home or neighborhood; they tell you to **shelter in place**. Depending on the event, a safe area may be the basement or ground floor in a room or closet with no outside windows.
- Your family should have a survival kit. The contents will be different depending on where you live, but the kit should contain items you would need if your home had no climate control, water, or other necessities. Your battery-operated radio and first aid supplies would be part of the kit.
- Remember to check on family members and neighbors.

Safety during Extreme Cold

- Shelter in place.
- If you **must** travel, keep a winter survival kit in the car.
- Bring pets inside
- Wear several layers of warm clothing, gloves or mittens, and **always** keep your head covered.
- Cover your mouth to prevent frigid air from entering your lungs.

Hurricane Safety

- If you live in a coastal area and are ordered to evacuate, turn off household utilities like water and electricity, lock your home, and leave as soon as possible. Bring emergency supplies from your survival kit. Bring cash, credit cards, and insurance information as well.
- If you are advised to shelter in place, learn how to prepare your home for high winds and water. Remain indoors.
- Clean bathtubs with bleach and fill them with water for flushing and washing~~n~~ ot for drinking.
- Set the refrigerator for maximum cold and open it as little as possible.
- During the worst of the storm, stay away from windows and doors.

Safety during Heat Waves

- Find air conditioning. If you do not have air conditioning in your home, many government buildings, including libraries, will allow you to stay there during the worst heat of the day.
- Avoid strenuous activities.
- Wear light clothing.
- Drink plenty of fluids.
- Watch for heat cramps, heat exhaustion, and heat stroke.
- Never leave people or pets in a closed car.

Earthquake Safety

- Earthquakes can strike without warning. Before one strikes, go to each room in your home and identify the best place to "drop, cover, and hold on."
- Anyone who is driving a vehicle should pull over and make sure the parking brake is on.
- If you are outdoors, stay away from buildings.
- If you are in a building, do not run outside.
- If you are in bed, roll over face down and cover the back of your head and your neck with a pillow.

Tornado Safety

- If you live in an area where tornados are common, your family must keep a close eye on thunderstorm activity. Have a family plan that includes a meeting place where everyone knows to go after a storm.
- The safest place in a tornado is below ground level, often called below grade. If you do not have a basement in your home, try to identify a nearby building with a basement and make sure you can have access to it in an emergency.
- Go to a low room with no windows during a severe thunderstorm or if you hear a tornado siren.
- If you get caught outside, remember to seek shelter only in a sturdy building. Mobile homes, sheds, storage units, and tents are NOT safe.
- If you cannot get to a safe building, look for the lowest ground you can find, perhaps a ditch or ravine. Get down as low as possible and cover your head.

Tsunami Safety

The safest action to take if there is a **tsunami** warning is to get to high ground as far away from the coast as possible.

No matter where you live, it is a good idea to practice safety drills and make sure family members know what to do in case of an emergency.




NATURAL DISASTERS





16.4 LESSON REVIEW

1. Ask your parents to help you identify possible extreme natural events that occur where you live. Could you possibly have:

- ☐ Heat wave
- ☐ Extreme cold
- ☐ Hurricanes/typhoons
- ☐ Thunderstorms
- ☐ Tornados
- ☐ Earthquakes
- ☐ Tsunami

2. Help your parents put together an emergency survival kit. In addition to a battery-operated radio and first aid supplies, what other items would you need in your area? Remember this survival kit would help your family meet basic needs of food, water, and protection from heat and cold in the event you lost utilities and were unable to leave your home.

_____

_____

_____

16.5 WHATSOEVER YOU DO FOR THE LEAST OF MY BRETHREN...

> Then shall the king say to them that shall be on his right hand: Come, ye blessed of my Father, possess you the kingdom prepared for you from the foundation of the world. For I was hungry, and you gave me to eat: I was thirsty, and you gave me to drink: I was a stranger, and you took me in: Naked, and you covered me: sick, and you visited me: I was in prison, and you came to me. Then shall the just answer him, saying: Lord, when did we see thee hungry and fed thee: thirsty and gave thee drink? Or when did we see thee a stranger and took thee in? Or naked and covered thee? Or when did we see thee sick or in prison and came to thee? And the king answering shall say to them: Amen I say to you, as long as you did it to one of these my least brethren, you did it to me.
>
> Matthew 25:35-40

In the last two chapters, you learned that an **extreme natural event** is a change in the Earth's environment that can cause tremendous loss of human life and destruction to property. Often areas hit by these events are poor and lack the resources to provide medical care and other basic services to survivors. Restoring infrastructure, including roads, railroad, bridges, and airports, can take years and very often requires help from other nations.

Indian Ocean Tsunami

On December 26, 2004, there was an earthquake with a magnitude over 9.0 in the Indian Ocean off the coast of the Indonesian island of Sumatra. As briefly mentioned, the earthquake caused a massive seven-hour tsunami that killed more than a quarter of a million people. Loss of life and property was worst in Indonesia, Sri Lanka, India, Maldives, and Thailand.

International aid poured in. The United States government alone provided hundreds of millions of dollars to the efforts. The United States and other nations sent hospital ships and troops to help with search and rescue operations. Dozens of military vessels from the United States were able to provide 340,000 liters (90,000 gallons) of freshwater daily, *each*.

Catholic Disaster Relief

Throughout history, Catholic monasteries, convents, dioceses, and parishes have worked tirelessly to bring relief to those affected by natural disasters. This important work was formalized in the United States in 1990 when the U.S. Conference of Catholic Bishops tasked Catholic Charities USA with the job of coordinating responses to disasters in the United States on behalf of the Church.

Various Catholic organizations, including Cross Catholic Outreach and Catholic Relief Services, provide recovery supplies to nations all over the world who have experienced natural disasters.

CHAPTER 16 REVIEW

A. Tectonic plates
B. Volcano
C. Tsunami
D. Earthquake
E. Lithosphere
F. Pyroclastic flow
G. Fault
H. Intensity
I. Lahar
J. Dormant volcano
K. Moment magnitude scale (Mw)
L. Magnitude
M. Extinct volcano
N. Tsunami wave train
O. Meridian

Match the words above with the descriptions and place the correct letter on the line.

1. _____ Mixture of searing hot rock and gases that appear to be a giant filthy cloud.
2. _____ Scale presently used to measure earthquake magnitude.
3. _____ Describes the severity of earthquake tremors.
4. _____ Active volcano that is not erupting, but is expected to in the future.
5. _____ Has not had an eruption in the past 10,000 years.
6. _____ A giant wave.
7. _____ Mountain built up around a vent in the Earth's crust.
8. _____ The Earth's hard outer crust.
9. _____ Series of extremely long waves, with tens to hundreds of miles between them.
10. _____ Sudden and violent shaking of the ground, sometimes causing great destruction.
11. _____ Line along which two tectonic plates meet.
12. _____ Describes how far-reaching an earthquake is—its size.
13. _____ Immense slabs of rocks that make up the Earth's hard outer crust.
14. _____ Huge, fast-moving mudslide.

CUMULATIVE REVIEW

Convection	Permafrost	Atmospheric pressure
Anemometer	Hail	Greenhouse effect
Heat index	Whiteout	Relative humidity
Weather	Storm surge	Climate
Mesocyclone	Precipitation	Terrain

Write the correct answer from the word box on the line.

1. _____ is a condition caused by a blizzard that makes it difficult or impossible for a driver to see the road ahead.

2. _____ how hot it will feel outside due to the combination of the temperature and the relative humidity.

3. _____ is the movement of air due to differences in temperature.

4. A _____ is spinning air, horizontal to the Earth's surface, created by wind shear in the lower atmosphere.

5. A _____ occurs when the low pressure, high winds, and high waves cause the sea level to rise.

6. _____ is the condition of the atmosphere in a place at a given point in time.

7. _____ is the average weather in a location over a period of years.

8. _____ is permanently frozen soil.

CONT.

9. _____ describes landforms in a particular location, including flat prairies, hills, or mountains.

10. The _____ refers to heat trapped by gases in the atmosphere, causing global warming.

11. _____ is the amount of water in the air compared to the total amount of water the air can hold.

12. _____ is the weight of air molecules pressing against any point.

13. An _____ is used to measure wind speed.

14. _____ includes solid (frozen) and liquid water that falls from the clouds to the Earth's surface.

15. _____ is a pellet of ice that falls from the sky during warm weather months.

EARTH SCIENCE
for Young Catholics

Earth Science for Young Catholics takes students on a fact-filled tour of planet Earth. The book opens with a thorough review of general science topics including the Scientific Method and measurement, with a strong emphasis on the international metric system. Newton's Laws of Motion and his Laws of Universal Gravitation are presented to give students an understanding of the forces that shape the planet.

Earth's internal structure and Tectonic Plate Theory, as well as landforms, soil, saltwater and freshwater, are investigated. Other topics include atmosphere, the biosphere, weather, and climate. Extreme weather, natural events, and unusual landforms are sure to attract student interest. The book closes with a look at how populations meet their energy needs and discusses responsible stewardship of the environment.

Earth Science for Young Catholics is filled with colorful graphics to excite interest and aid understanding. Written for homeschooled students, the worktext is intentionally easy to use.

ISBN 978-1-60704-177-1
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1350 Progress Drive
Front Royal, VA 22630
(540) 636-9990

P-SC06-31