Geoscience

Geoscience

Suggested pacing: 3 lessons per week

Unit	Lesson	Date	Topic	Pages
GEOLOGY	Intro	Wed, Jan 21	Introduction and Tips for Success	
	1	Mon, Jan 26	Continental Drift	4-5
	2	Wed, Jan 28	Plate Boundaries	6-7
	3	*Self-paced*	Activity: A Ring of Fire	8-11
	4	Mon, Feb 2	Weathering vs Tectonics	12-13
	5	Wed, Feb 4	Faults and Earthquakes	14-15
	6	*Self-paced*	Activity: Shake, Rattle, Resilient	16-17
	7	Mon, Feb 9	Go With the Flow	18-19
	8	Wed, Feb 11	The Cryosphere	20-21
	9	*Self-paced*	Activity: Stream Table Study	22-23
	10	Mon, Feb 16	How Old are Rocks?	24-25
	11	Wed, Feb 18	Geologic Time	26-28
	12	*Self-paced*	Geology Unit Assessment	29-31
	13	Mon, Feb 23	Geology Quiz Show	-
WEATHER & ATMOSPHERE	14	Wed, Feb 25	Relative Humidity	32-34
	15	*Self-paced*	Activity: Cloud in a Jar	35
	16	Mon, Mar 2	Heat Index and Windchill	36-37
	17	Wed Mar 4	Air Masses and Fronts	38-39
	18	*Self-paced*	Activity: Humidity Lab	40-41
	19	Mon, Mar 9	Global Weather Patterns	42-43
	20	Wed, Mar 11	Ocean Currents	44-45
	21	*Self-paced*	Activity: Convection Convention	46-49
	March 16-20: SPRING BREAK			
	22	Mon, Mar 23	ENSO: El Niño-Southern Oscillation	50-51
	23	Wed, Mar 25	The Weather Forecast	52-53
	24	*Self-paced*	Activity: Tropical Storm Quest	54-57
	25	Mon, Mar 30	Tropical Cyclones	58-59
	26	Wed, Apr 1	Weather Quiz Show	
	27	*Self-paced*	Weather & Atmosphere Unit Assessment	60-63
	28	Mon, Apr 6	Understanding Ecosystems	64-65
ECOLOGY & HUMAN SYSTEMS	29	Wed, Apr 8	Keystone Species	66-67
	30	*Self-paced*	Activity: Stackable Food Chain and Food Web	68-71
	31	Mon, Apr 13	Nutrient Cycles	72-73
	32	Wed, Apr 15	Succession	74-75
	33	*Self-paced*	Activity: Composting	76-79
	34	Mon, Apr 20	Ecosystem Resilience	80-81
	35	Wed, Apr 22	Human Geography	82-83

Unit	Lesson	Date	Topic	Pages
ECOLOGY & HUMAN SYSTEMS	36	*Self-paced*	Activity: Invasive Species Comic	84-85
	37	Mon, Apr 27	Agriculture	86-87
	38	Wed, Apr 29	Greenhouse Effect & Energy Choices	88-89
	39	*Self-paced*	Activity: Natural Resource Scavenger Hunt	90-91
	40	Mon, May 4	5 Myths About Climate Change	92-94
	41	Wed, May 6	5 Solutions to Climate Change	95-97
	42	*Self-paced*	Ecology & Human Systems Unit Assessment	98-101
	43	Mon, May 11	Final Quiz Show	

SUPPLY LIST:

Lesson 3 - Map the Ring of Fire
- Pencil & colored pencils or crayons
- Internet connection or book(s) to use for researching volcanoes and earthquakes

Lesson 6 - Shake, Rattle, Resilient
- A small box
- Cardboard (at least 3x as long as the small box)
- Cylindrical pencils or markers
- Smart phone
- Various household objects

Lesson 9 - Stream Table Study
- Sand and gravel
- Plastic paint tray or a long bin or storage container
- Drill or nail
- Rocks or brick to elevate tray/container
- Cups or an empty gallon jug

Lesson 15 - Cloud in a Jar
Adult supervision recommended
- 4 glass jars with lids
- Ice
- Water
- Matches
- Paper or tape and pen for making labels

Lesson 18 - Humidity Lab
- A small piece of cloth or gauze
- Fan
- Rubber band
- 2 identical thermometers

Lesson 21 - Convection Convention
Adult supervision recommended
- 2 to 4 identical clear cups
- 2 paper cups (will need to be cut)
- Stiff wire taller than the paper cups
- Scissors or exacto knife
- Thin flat piece of plastic
- Food coloring
- Water (some of it heated to be very warm)
- Ice cubes
- Salt
- Tray
- 1 large clear container
- Pencil
- Matches
- Tea candle

Lesson 24 - Hurricane Tracker
- Pencil & colored pencils or crayons
- Internet connection or book(s) to use for researching a historic hurricane

Lesson 30 - Build a Food Web
- Cardboard
- Colored pencils, crayons, or markers
- Yarn
- Tacks or pins
- Scissors
- Gluestick

Lesson 33 - Competing Compost Jars
- 2 identical clear containers
- Lids for the containers with ventilation holes OR 2 pieces of cloth and 2 rubber bands
- Newspaper
- Scissors
- Grass clippings or vegetable scraps such as carrot peels, apple cores, or squash rinds etc
- A small sample of soil, if possible, containing invertebrates such as earthworms, millipedes etc

Lesson 36 - Invasive Species Comic
- Cardboard
- Colored pencils, crayons, or markers
- Scissors
- Gluestick

Lesson 39 - Natural Resource Scavenger Hunt
- Pencil and lesson handout

CONTINENTAL DRIFT

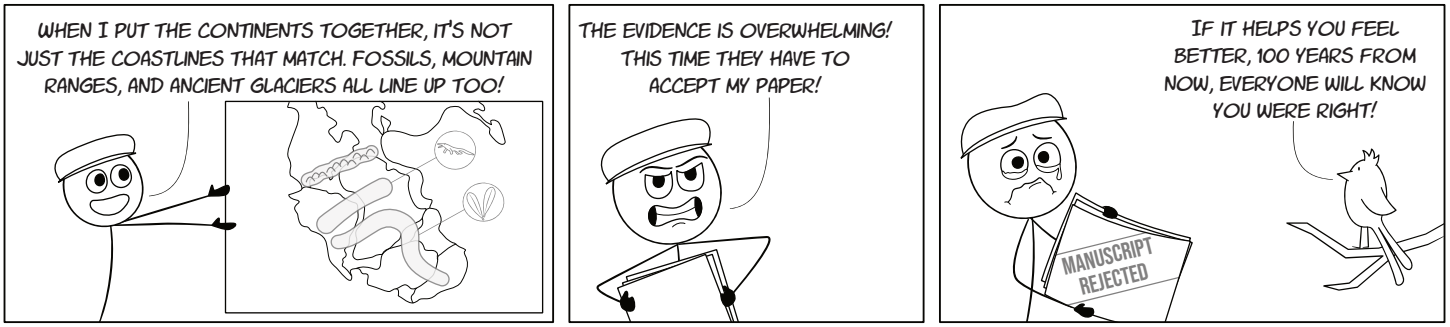


PLATE TECTONICS

THE BEDROCK THEORY OF GEOLOGY

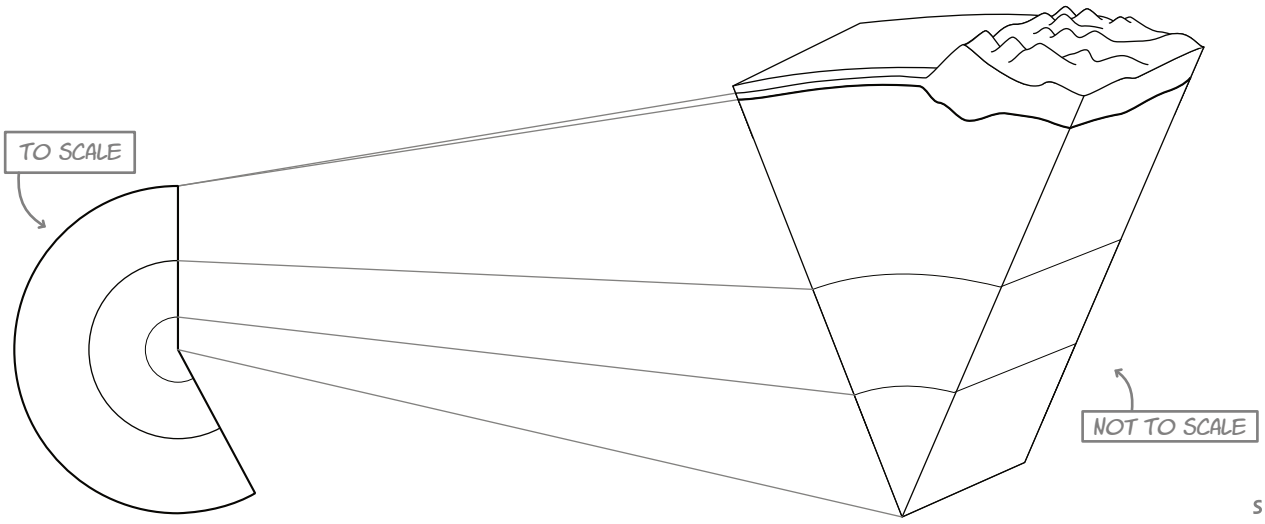
WHAT IT IS

HOW IT WORKS

Draw lines to match the terms with the correct description, then label each term on the diagram below:

Crust	*Inner Core*	*Mantle*	*The "Moho" or Mohorovičić discontinuity*	*Outer Core*

The hottest layer of the planet	*Solid silicate rock that is brittle near its surface*	*A silicate rock layer that makes up more than 60% of the mass of the Earth*	*A liquid layer mostly made of iron and nickel*	*The boundary between crust and mantle; the depth where earthquake waves speed up as they move from less-dense crust into denser mantle*



Use the descriptions below to identify and color each of the major tectonic plates:

RED — **Indian Plate**
Smallest major plate; formed the Himalayas

PINK — **North American Plate**
This plate is moving over the Yellowstone hotspot

ORANGE — **South American Plate**
Contains the Amazon rainforest

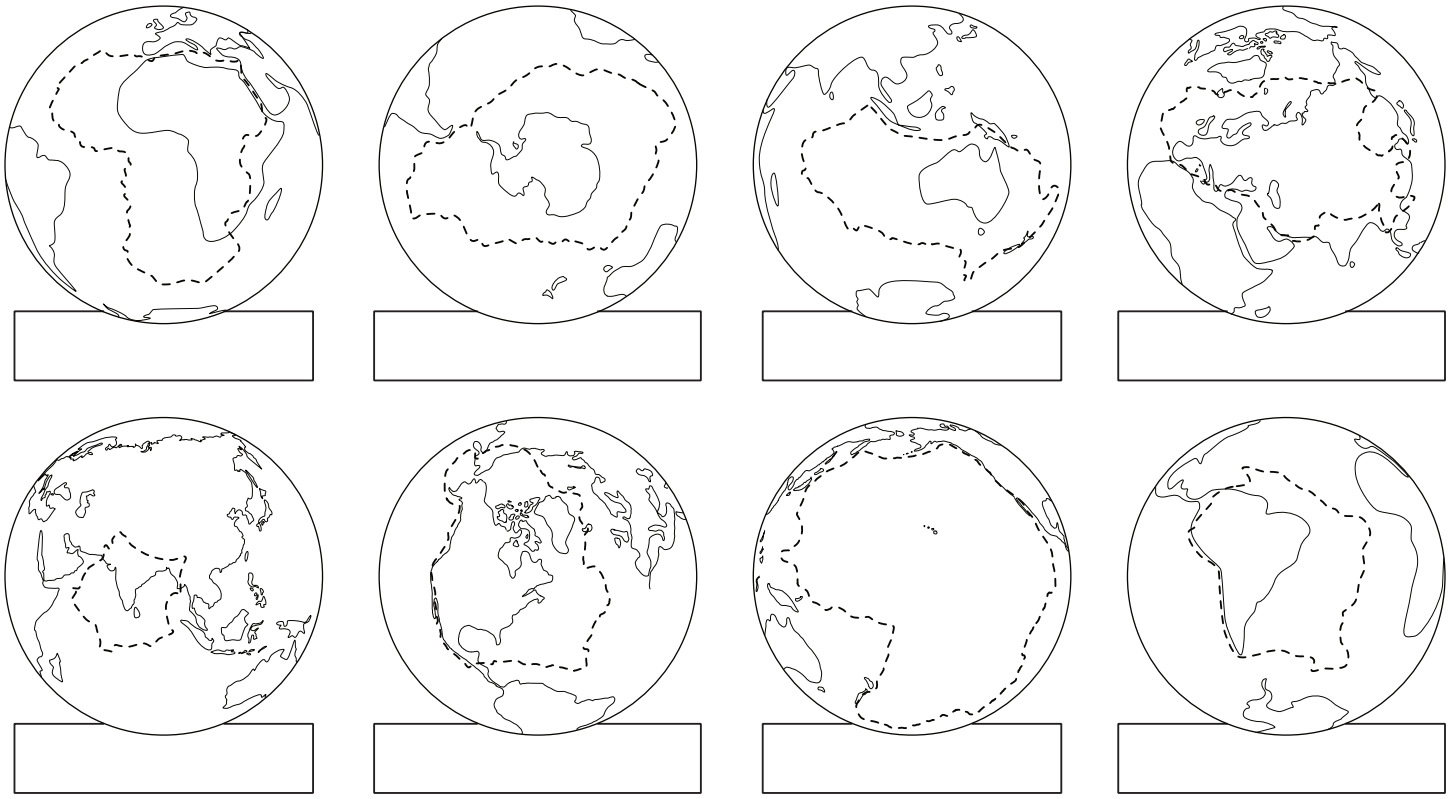
YELLOW — **African Plate**
A plate bordered by rift zones that form deep lakes

GREEN — **Australian Plate**
Fastest moving continental plate; north at 6.9 cm/yr

LIGHT BLUE — **Antarctic Plate**
A plate with no human cities, only research stations

BLUE — **Pacific Plate**
Largest tectonic plate; primarily oceanic crust

PURPLE — **Eurasian Plate**
This plate contains most of Europe



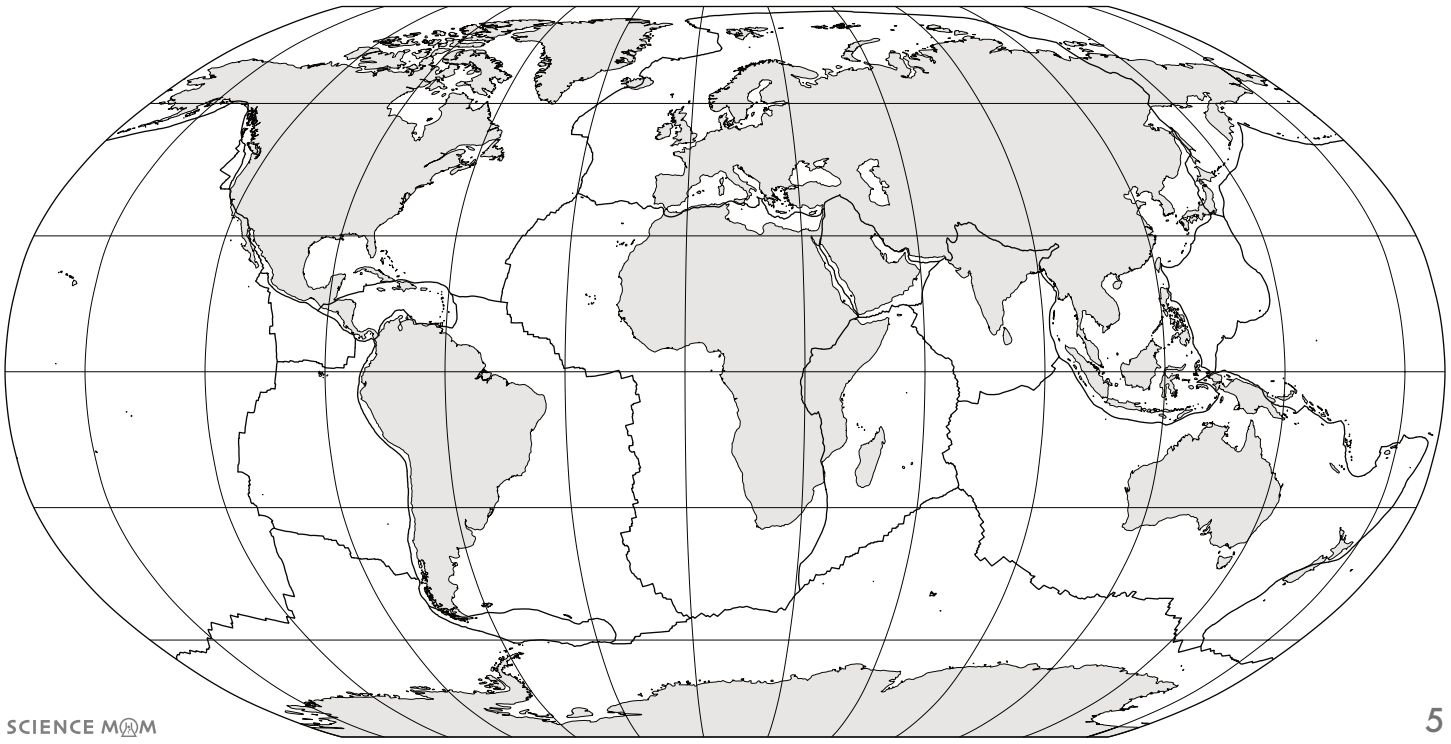
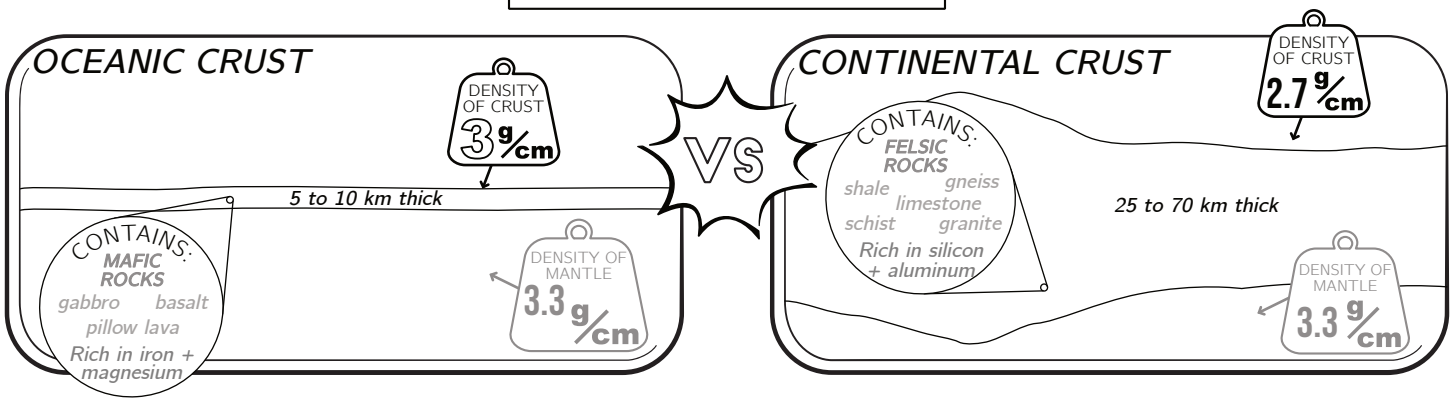
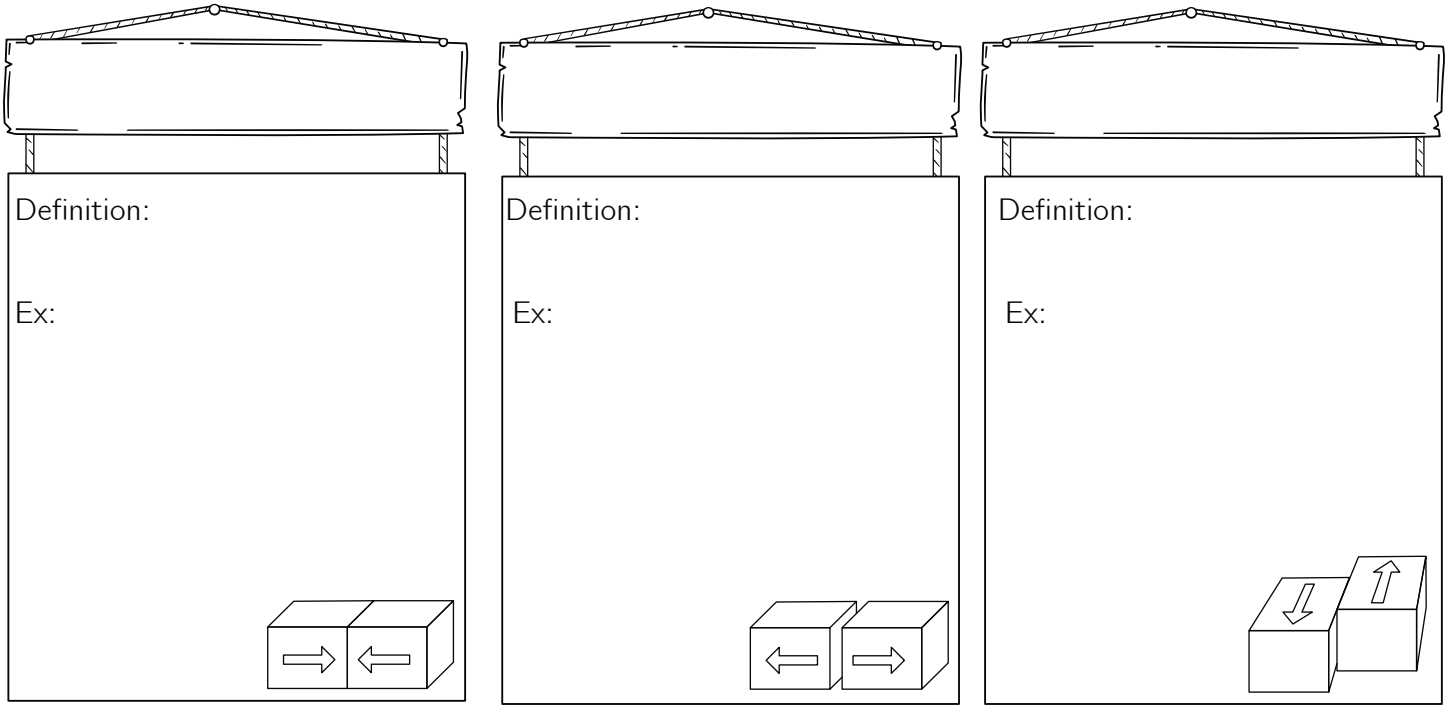


PLATE BOUNDARIES



TYPES OF PLATE BOUNDARIES



Definition:

Ex:

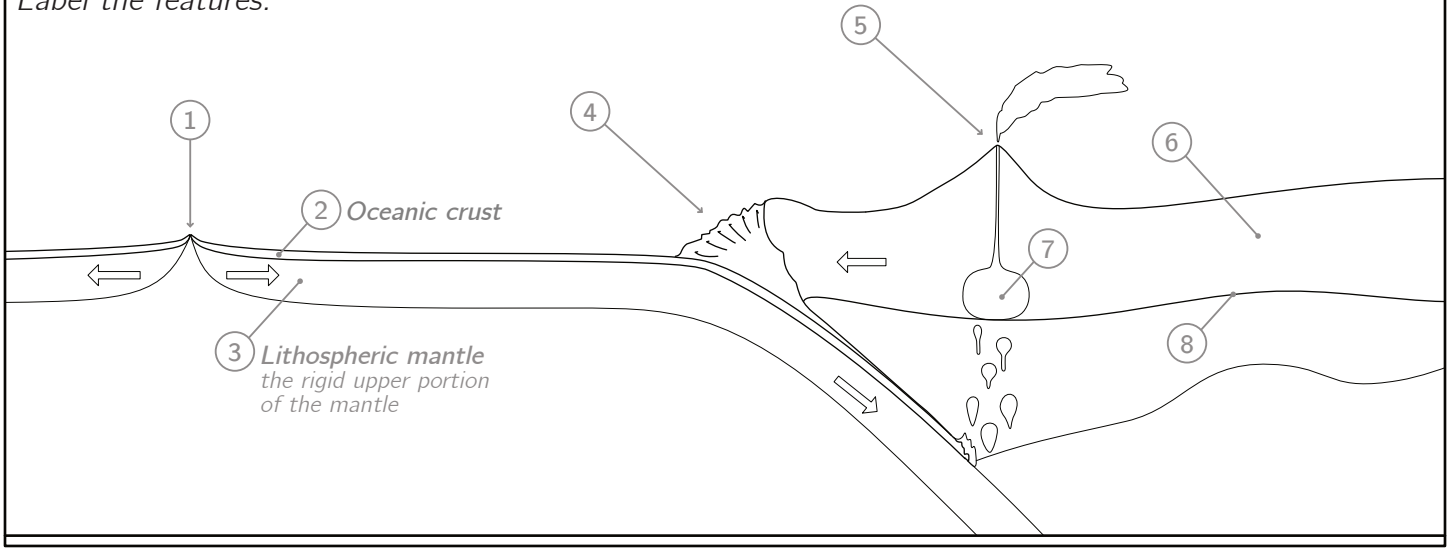
Definition:

Ex:

Definition:

Ex:

Label the features:



Explain how plate tectonics caused or influenced each event or geologic feature:

COTOPAXI

In 1877, Cotopaxi erupted with a violent explosion that destroyed the town of Latacunga, Ecuador.

The volcano produced enormous pyroclastic flows of hot gas and volcanic material which melted all of the ice cap on the volcano. This caused mudflows or lahars that traveled to the Pacific Ocean, more than 100 km away.

2002 DENALI EARTHQUAKE

This magnitude 7.9 quake lasted for almost 3 minutes. It caused thousands of landslides, fractured glaciers, and displaced roads and streams up to 29 feet from their original location. It even caused sloshing in lakes as far away as Louisiana!

LAKE BAIKAL

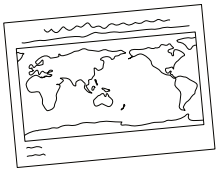
Lake Baikal is over 1,600 m deep and contains approximately 20% of Earth's surface water. It is both the largest and oldest freshwater lake in the world, and is getting larger by approximately 4 mm each year. Deep hydrothermal vents release heated, mineral-rich water into the lake.

HAWAIIAN ISLANDS

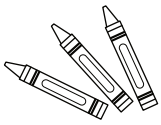
The Hawaiian-Emperor seamount chain is an enormous chain of volcanic islands, atolls, and seamounts that stretch for 6,200 km across the Pacific Ocean. The eastern-most islands contain the most active volcanoes on Earth.

ACTIVITY: A RING OF FIRE

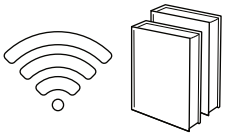
MATERIALS



World map printout from page 11 OR any world map with latitude and longitude



Crayons, colored pencils, or other coloring supplies



Internet connection OR books about volcanoes & earthquakes

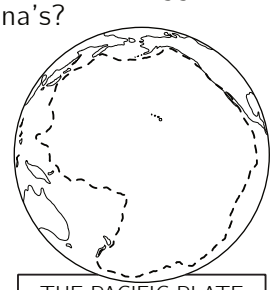
GOALS

- To recognize patterns with how volcano and earthquake locations relate to plate boundaries
- To discover and learn more about the "Ring of Fire"
- Practice researching a topic independently

DIRECTIONS

1. Read the charts on page 10 showing the largest volcanoes and earthquakes that have occurred in the past two decades. Use the latitude and longitude coordinates to find the locations of each earthquake and volcano and mark them with different colors on the map.
2. Use the completed map and other resources such as books or an internet search engine to answer questions A through F on this page and page 9.

A The zone with highest volcanic and quake activity on Earth is called "The Ring of Fire." Bob says the Ring of Fire circles the entire Pacific plate. Raina says the Ring of Fire is shaped like a horseshoe that's bigger than the Pacific plate. Do the points you plotted on page 11 support Bob's argument or Raina's?



THE PACIFIC PLATE

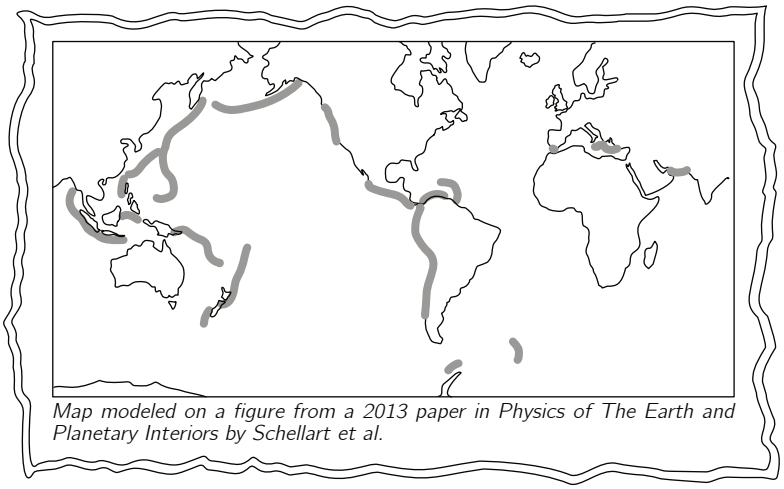
B Why is there is no "Ring of Fire" around the Atlantic Ocean?

C How is volcanic activity at a divergent boundary (like Iceland) different from volcanic activity at a convergent boundary (like Japan)? Which location is typically more dangerous?

D The grey lines in this map show the location of the world's subduction zones.

If you were given the house of your dreams but it had to be built on one of these subduction zones, which location would you choose and why? Would you make any modifications to your dream house due to the location?

If desired, use another paper to illustrate your dream home and describe where it would be.



Map modeled on a figure from a 2013 paper in Physics of The Earth and Planetary Interiors by Schellart et al.

E Look it up! What percentage of the world's volcanoes and earthquakes occur on the Ring of Fire?

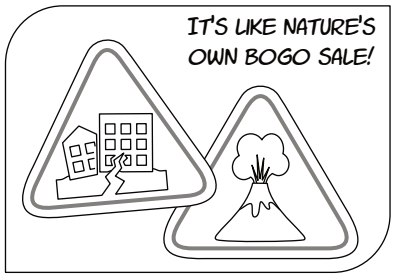
F Between 1900 and 2025, there have been 5 earthquakes with a magnitude of 9 or greater:

- 1952 Severo-Kurilsk earthquake
- 1960 Valdivia earthquake
- 1964 Alaska earthquake
- 2004 Indian Ocean earthquake
- 2011 Tōhoku earthquake

Choose one of these quakes to research. How long did shaking last during the main quake? Did the quake produce tsunamis or landslides? Create a visual of how the landscape/towns looked before and after the quake. You can use 3-D materials such as lego blocks, draw a picture, or find photos from online. If the same quake happened were to happen again in the same area, what disaster preparation steps would you recommend?

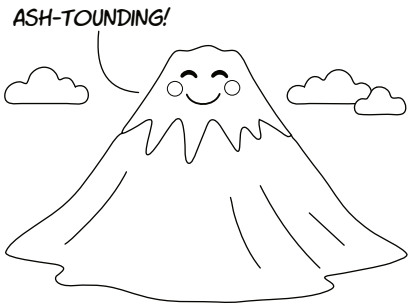
FACT OR FICTION? *Write your verdict below each statement:*

An area with large earthquakes will also experience high levels of volcanic activity



Scientists can predict the date and time a volcano will erupt, similar to how they can predict when an eclipse will occur.

Measured from base to peak, the tallest mountain on Earth is a volcano.



YEAR	VOLCANO	LAT	LONG	VEI or DESCRIPTION
2022	Hunga Tonga–Hunga Ha'apai	-20.55	-175.38	VEI 5; plume reached the mesosphere
2008	Chaitén	-42.83	-72.65	VEI 5; rhyolitic eruption
2011	Puyehue–Cordón Caulle	-40.59	-72.12	VEI 5; widespread ash fallout.
2011	Grímsvötn	64.42	-17.32	VEI 4; ash plume up to 20 km
2019	Raikoke	48.29	153.25	VEI 4; with significant SO_2 release
2020	Taal	14.0	121	VEI 4; phreatomagmatic eruption
2008	Kasatochi	52.18	-175.51	VEI 4; large SO_2 and ash release.
2014	Kelud	-7.94	112.31	VEI 4; ash plume to 26 km
2018	Anak Krakatau	-6.1	105.42	VEI 3–4; tsunami
2006	Augustine	59.36	-153.44	VEI 3–4; ash deposits over 200 km away
2014	Ontake	35.89	137.48	VEI 3; Phreatic eruption
2018	Fuego	14.48	-90.88	VEI 3; Produced deadly lahars
2015	Wolf	0.02	-91.35	VEI 2; Extensive lava flows.
2018	Kīlauea (Lower East Rift Zone)	19.42	-155.0	VEI 0; but ~1.4 km³ lava volume.
2021	Cumbre Vieja	28.57	-17.83	85 day-long eruption; 1 km³ lava

15 of the largest volcanic eruptions

VEI EXPLAINED

The volcanic explosivity index (VEI) measures the size or scale of an explosive eruption. It assigns a numerical value to the eruption based on volume of ejected material, cloud height, and qualitative descriptions of the eruption

A VEI of 0 or 1 describes an effusive eruption such as a relatively slow and calm lava flow from Kilauea on Hawai'i. These are occurring somewhere on Earth almost constantly.

An eruption with a VEI of 5 is a cataclysmic eruption that can send ash over 20 kilometers high and injecting substantial material into the troposphere. These occur roughly every 12 years.

Colossal eruptions with VEIs of 6 occur every 50-100 years. Eruptions with a VEI of 7 only occur every 500 - 1,000 years. The highest value (VEI 8) describes eruptions such as the Yellowstone supervolcano 1.2 mya. Fortunately, these occur more than 50,000 years apart.

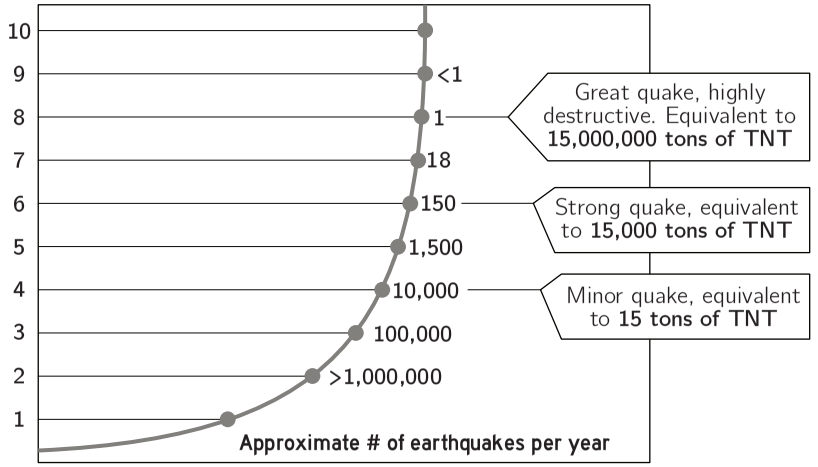
15 of the largest earthquakes from the last 25 years

YEAR & EARTHQUAKE NAME	Mw	LAT	LONG
2011 Tōhoku, or Great East Japan Earthquake	9.1	38.30	142.37
2004 Indian Ocean/Sumatra Earthquake	9.1	3.30	95.98
2025 Kamchatka Earthquake	8.8	52.5	160.24
2010 Chile Earthquake	8.8	-36.12	-72.9
2012 Indian Ocean Earthquakes	8.6	2.33	93.06
2007 Bengkulu Earthquakes	8.4	-4.44	101.37
2017 Chiapas Earthquake	8.2	15.02	-93.90
2014 Iquique Earthquake	8.2	-19.61	-70.77
2018 Fiji Deep Earthquake	8.2	-18.11	-178.15
2021 Chignik Alaska Earthquake	8.2	55.36	-157.89
2021 South Sandwich Islands Earthquake	8.1	-58.38	-25.26
2007 Solomon Islands Earthquake	8.1	-8.47	157.04
2009 Samoa Earthquake	8.1	-15.49	-172.1
2006 Tonga Earthquake	8.0	-20.19	-174.12
2007 Peru Earthquake	8.0	-13.39	-76.6

All lat/long values from USGS

The Moment Magnitude Scale (Mw)

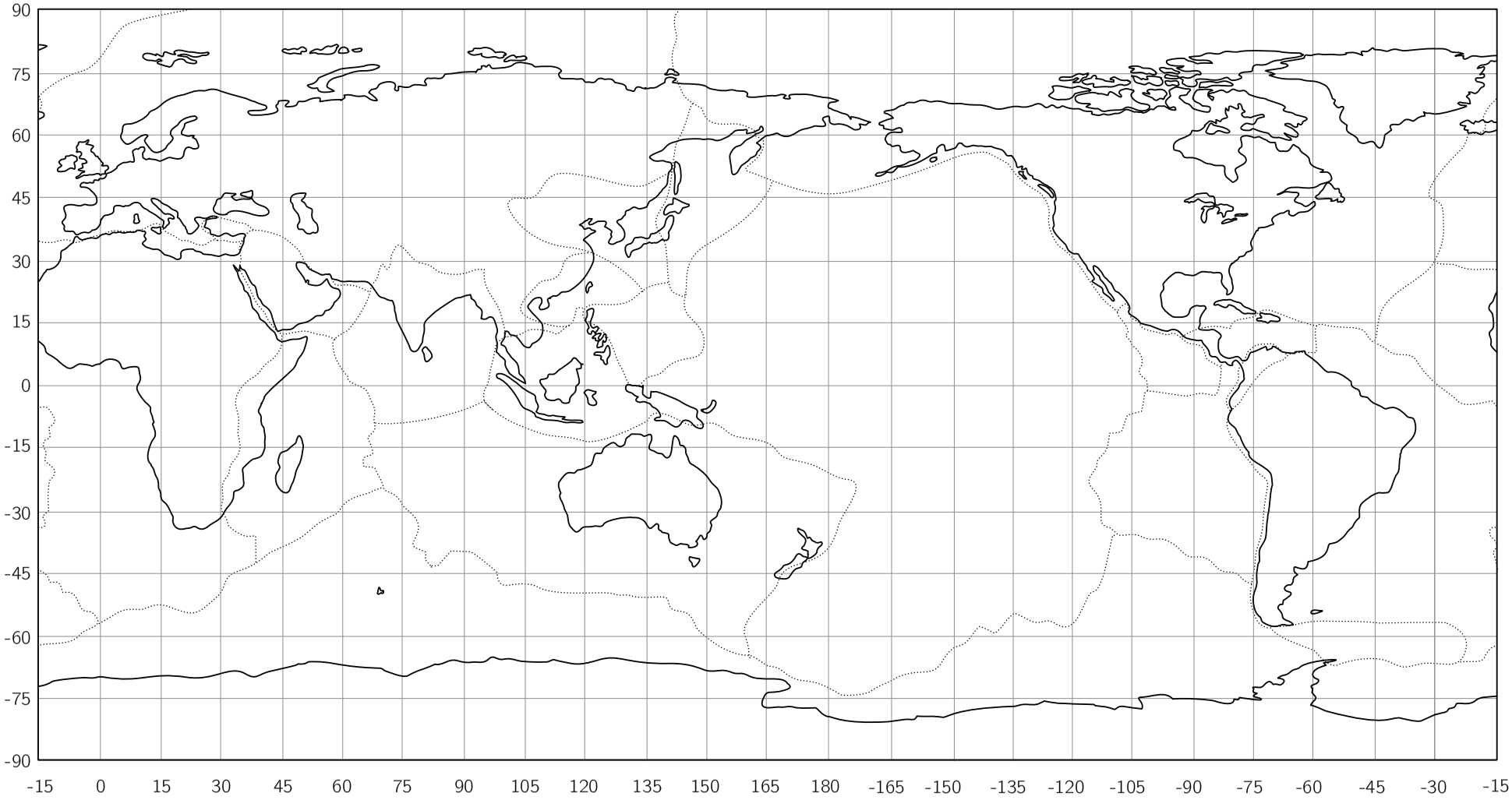
similar to but more accurate than the older Richter scale



10.6 is the highest possible value because at that level, the entire crust of the Earth would break apart.

A PACIFIC-CENTERED WORLD MAP

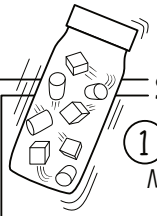
This is an equirectangular projection - also known as "Plate Carrée" (French for flat square). It is a useful for plotting latitude and longitude but it is NOT accurate for distances and shapes of landmasses. The closer a landmass is to the poles, the more distorted it is.



○ Earthquake

△ Volcanic Eruption

Weathering vs Tectonics



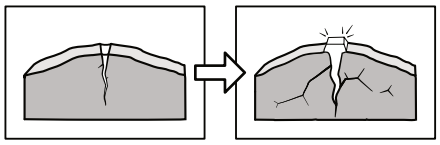
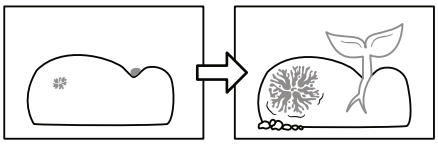
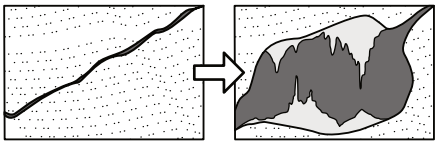
SHAKE BOTTLE TEST

1. **Sugar cubes + Chalk:**
   Make a prediction, which material will change in shape more after 1 min of shaking?
   ☐ *SUGAR CUBES* ☐ *CHALK* **RESULT:** _____

2. **Chalk + Aquarium Gravel:**
   Make a prediction, which material will change in shape more after 1 min of shaking?
   ☐ *CHALK* ☐ *GRAVEL* **RESULT:** _____

3. **Aquarium Gravel + Steel ball bearings:**
   Make a prediction, which material will change in shape more after 1 min of shaking?
   ☐ *GRAVEL* ☐ *STEEL* **RESULT:** _____

*Draw lines to match each type of **weathering** with its corresponding description. Then list examples of each:*

Mechanical	Chemical	Biological
The breaking of a rock into smaller pieces without any chemical change occurring; also called physical weathering	Physical or chemical change to a rock which is caused by living organisms	The chemical composition of a rock is changed through reactions with substances such as water and oxygen
		
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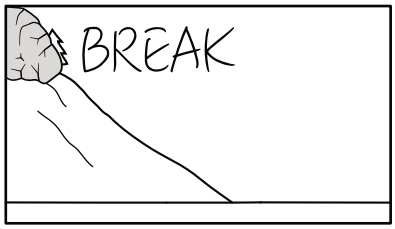
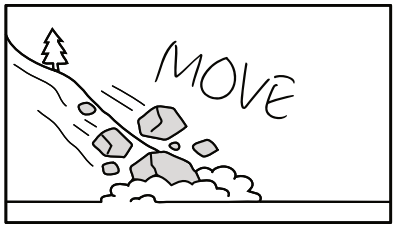
WEATHERING



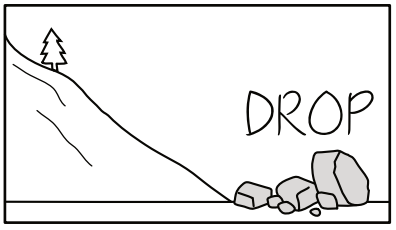
The breakdown of rocks or minerals into smaller pieces

EROSION



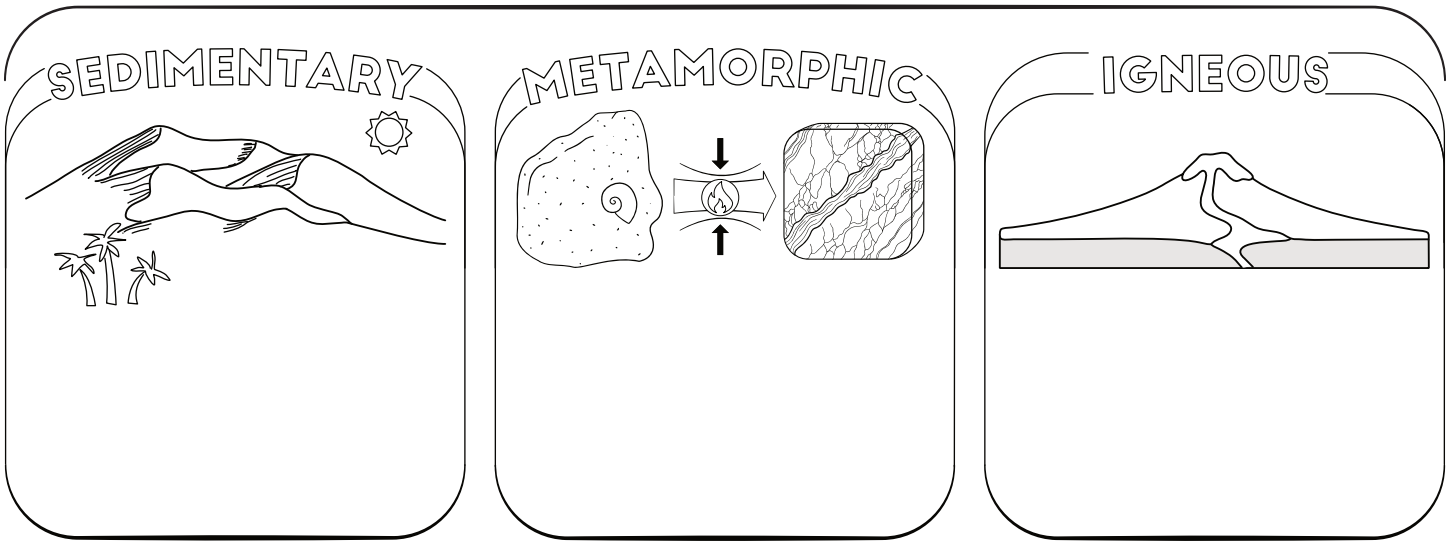
The movement of weathered material from one location to another by natural forces

DEPOSITION



When rock or sediment is deposited or laid down in a new location

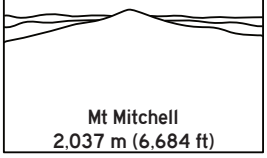
Review: How are the three types of rocks formed?



Are these famous mountains growing or shrinking?

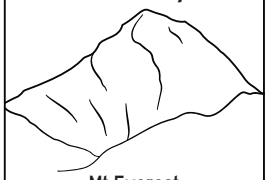
For each mountain, take notes on how it was formed, its estimated age, & how its size is changing.

The Appalachians



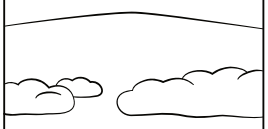
Mt Mitchell
2,037 m (6,684 ft)

The Himalayas



Mt Everest
8,849 m (29,032 ft)

The Hawaiian Islands



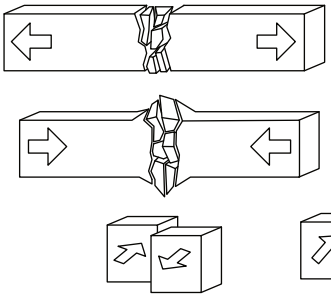
Mauna Loa
4,170 m (13,680 ft)

The Alps

Matterhorn
4,478 m (14,692 ft)

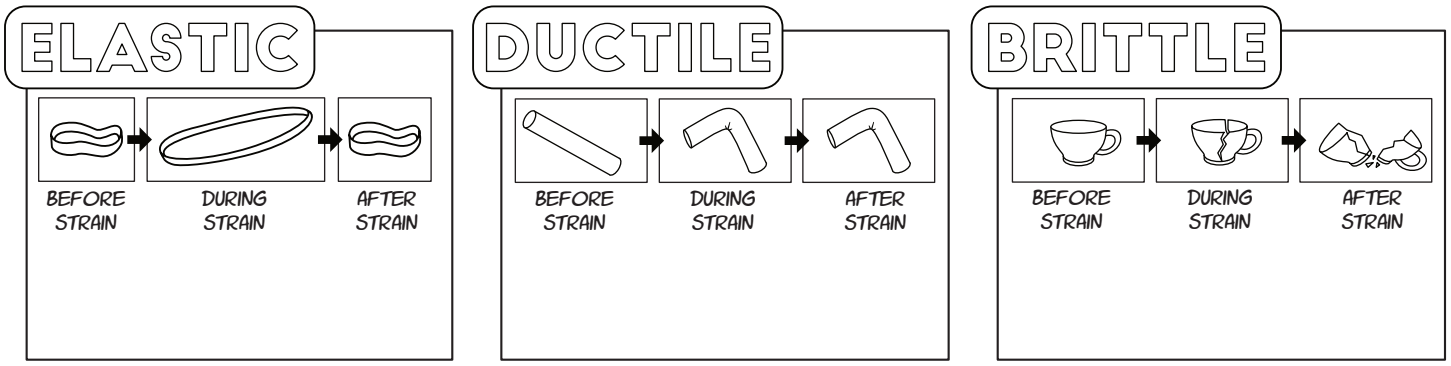
FAULTS AND EARTHQUAKES

Force applied to a rock is called **stress**. It comes in three types:



1. _____ is stress with forces pulling in opposite directions.
2. _____ is stress with forces pushing toward each other.
3. _____ is stress which is transverse, with rocks or regions of rock moving past each other.

If the stress a rock receives is greater than the internal strength of the rock, it will experience **strain**. Strain can deform a rock in three ways:



Whether a deformation is elastic, ductile, or brittle depends on a variety of factors such as rate of strain, rock strength, or temperature. Consider each factor below. Would it make a rock more or less likely to break?

HIGHER TEMPERATURE

- ☐ *LESS BRITTLE*
- ☐ *MORE BRITTLE*

LOWER STRAIN RATE
(STRESS APPLIED SLOWLY)

- ☐ *LESS BRITTLE*
- ☐ *MORE BRITTLE*

STRONGER ROCK

- ☐ *LESS BRITTLE*
- ☐ *MORE BRITTLE*

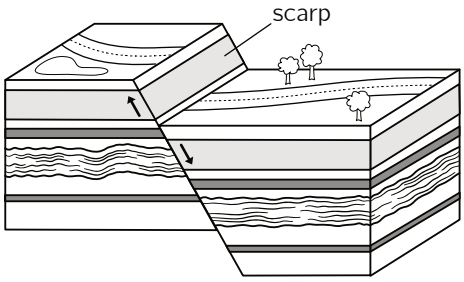
LOWER TEMPERATURE
(STRESS APPLIED SLOWLY)

- ☐ *LESS BRITTLE*
- ☐ *MORE BRITTLE*

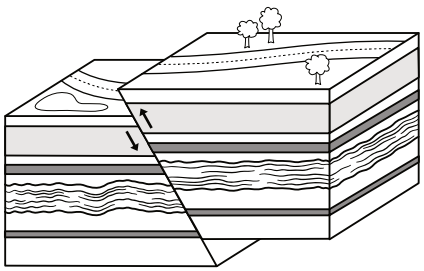
The location where a brittle deformation occurs between two sections of rock moving relative to each other is called a **fault**.

3 TYPES OF FAULTS

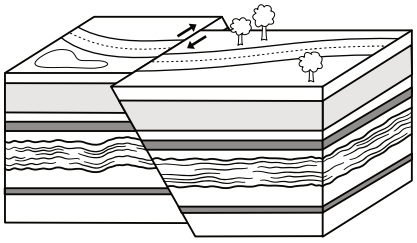
1. NORMAL



2. REVERSE



3. SLIP-STRIKE

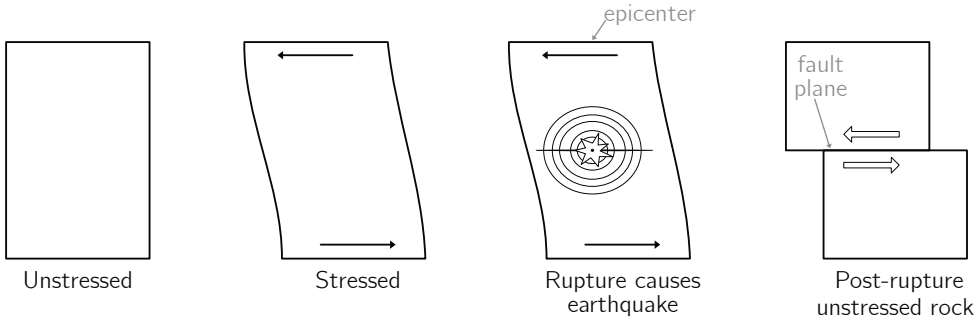


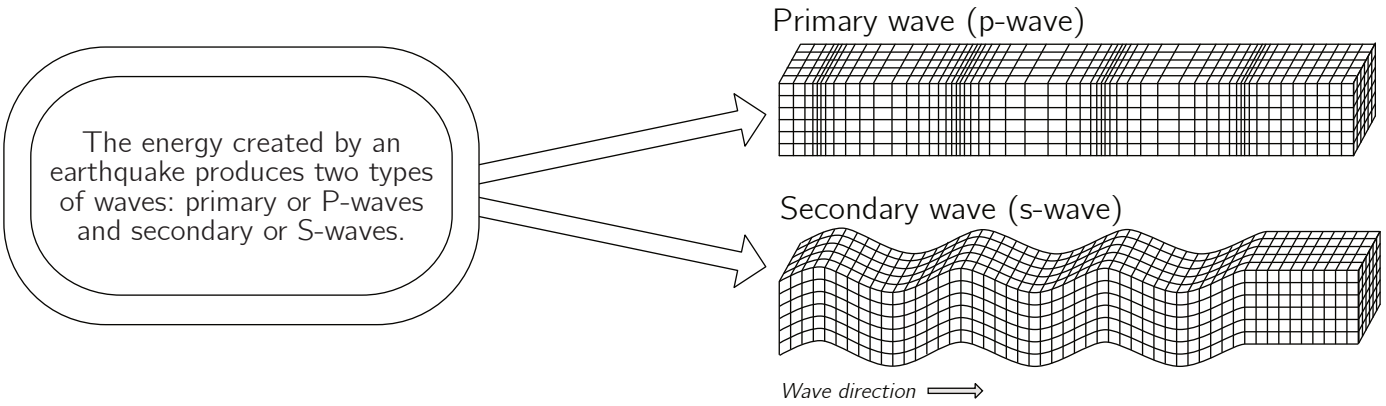
What type of STRESS do you think is most often associated with each type of fault?

FILL IN THE BLANKS (Words from the box may be used more than once or not at all)

earthquake	*energy*	*epicenter*	*fault*
focus	*larger*	*rupture*	*smaller*

An _____ is the release of _____ caused by movement of rock along a _____ . When applied stress exceeds the strength of the rock, it will _____. The initial point of rupture is called the _____. The surface location above the focus is called the _____. The greater the displacement of rock during an earthquake, the _____ the release of seismic energy will be.





Draw lines to match the following descriptions to either P-waves or S-waves:

Speed: about 6–8 km/s in crustal rock	P-Waves	Usually cause only minor shaking at the surface
Travel through solids only (not liquids or gases)		Motion is shear (side-to-side or up-and-down)
Cause stronger shaking and damage at the surface	S-Waves	Speed: about 3–4 km/s in crustal rock
Travel through solids, liquids, and gases		Motion is compressional (push–pull, like a slinky)

Think about it: If the fastest and least destructive waves (p-waves) reach seismic stations first, can we use that to predict destructive earthquakes? Why or why not?