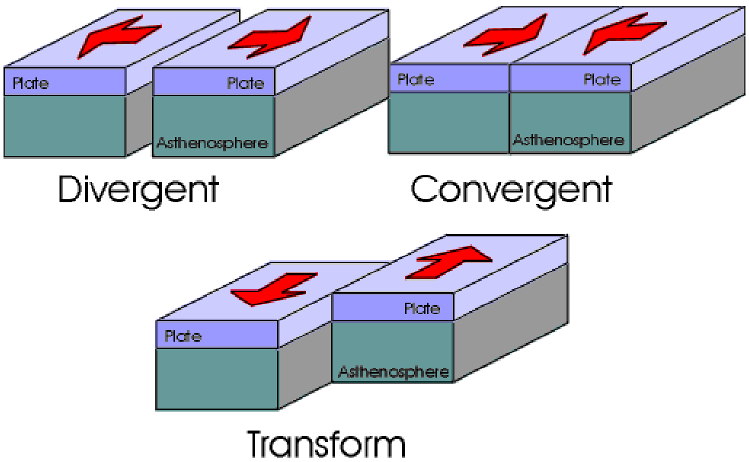
Discovering Plate Boundaries Lab (48 pts)

Goal: Students will be able to explain and justify conclusions based on data, maps, and diagrams about the formation and boundaries of geologic features due to tectonic plate movement.

Commented [CA1]: NGSS Standard: HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

Background: The Earth's outermost layer is fragmented into plates that are moving relative to one another as they sit on top of the hot, plastic mantel beneath them. The area where two plates meet is called a *plate boundary*. There are three different types of plate boundaries: *convergent* (plates coming together), *divergent* (plates moving apart), and *transform* (plates moving past one another). Scientists use data recorded from earthquakes, volcanic eruptions, age of rocks on the sea floor, and land features to determine the types of boundaries and how the plates are moving.

Commented [CA2]: Students should have a basic understanding of the differences in plate boundary types: plates split apart at divergent boundaries, come together at convergent, and slide past one another in transform. They should also have understanding of the landforms associated with each boundary.



Directions:

You will be assigned to one of four scientific specialties and will be asked to form a group of four with the other types of scientists.

The scientific specialties are:

A. Seismology (earthquake scientist)
B. Volcanology (volcano scientist)
C. Geography (land feature scientist)
D. Geochronology (age of rocks scientist)

Commented [CA3]: I have found it easier to assign specialties to students, group them, then pass out materials. I also make 11x17 laminated colored copies of each map. It can be a little pricey, but their color, clarity, and reusability is worth it.

Each Scientific Specialty group has been provided a world map showing data relevant to classifying plate boundaries and understanding plate boundary processes.

Your objective is to use the data to classify the world's plate boundaries as convergent, divergent, or transform.

Part 1: What are you looking for? (10 pts)

With your group, discuss what sort of data would help you identify the boundary type. What kind of boundaries would have mountain ranges? What kind of boundaries would have deep earthquakes? Fill out the chart below with as many pieces of evidence as you can think of. Feel free to use your notes!

Boundary types	What could occur at this boundary?	
Convergent	Continental- Continental: **Mountains (specifically closer to the surface), earthquakes, some volcanoes** **Ex: Himalaya Mountains**	Oceanic-Oceanic: **Volcanic island arcs, trenches, volcanic, subduction zone** **Ex: Japan, Indonesia**
Divergent	Continental- Continental: **Volcanos, earthquakes, rift valleys** **Ex: East Africa**	Oceanic-Oceanic: **Mid-ocean ridge, volcanos, volcanic islands, earthquakes** **Ex: Mid Atlantic ridge**
Transform	**Shallow earthquakes, faults**	

Part 2: What does the data say?

Look at your group's maps and talk about what you see. Look for patterns in how volcanos and earthquakes are distributed and where the rocks are old and young. Work as a group and let everyone talk about what they see. At this point, do not try to explain the data; just observe!

Part 3: Identify the plate boundaries (30 pts)

Using your data from each scientist's map, begin to collaborate on each known plate boundary type. Do this by obtaining a laminated plate boundary map from your teacher. At each labeled boundary (A-G), **color the convergent boundaries red, the divergent boundaries blue, and the transform boundaries green.** Use dry erase marker in order to classify the boundaries on the laminated plate boundary map (in case of mistakes or disagreements). Once you have a consensus, use the chart below justify your classification of the boundaries, citing data as your evidence, and explaining your reasoning.

Commented [CA4]: I usually give the students 5 minutes to fill this out themselves from their notes, then bring them back to discuss as a class. I also like to review with the PhET simulation on plate boundaries to illustrate how the differences in the plates boundaries and what is formed at each: https://phet.colorado.edu/en/simulation/legacy/plate-tectonics

Commented [CA6]: It's true that there are a lot of continental-oceanic convergent plate boundaries. These boundaries would have a classic subduction zone, with a volcanic mountain chain found along the coast (much like western North America and South America). Those subduction zones would have earthquakes far below the Earth's Surface

Commented [CA5]: Continental-continental boundaries may not have the typical subduction zone as both plates tend to have roughly the same density.

Commented [CA7]: The time here for discussion is critical. It gives the students a chance to really analyze the data and be critical of each other's claims. I usually give at least 10 minutes for this portion, but I've used more time if the discussion is good. Plan ample time and remember that disagreement can be a very good thing.

Plate boundary	Claim: What kind of boundary?	Evidence: What data leads you to this conclusion?	Reasoning: What process or phenomena explains this?
A	Divergent (oceanic-oceanic)	Young oceanic crust, volcanos, earthquakes	Plates are moving apart, causing new crust to form
B	Convergent (continental-continental)	Very high mountains, earthquakes close to the surface	Two plates of similar density are converging and
C	Convergent (continental-oceanic)	Volcanos, trench, mountains, old oceanic crust, earthquakes deep below the surface	Denser oceanic crust is being subducted under continental curst, causing volcanic mountains to form. Deep earthquakes release pressure.
D	Transform	Earthquakes close to the surface	Two plates are sliding past each other, the earthquakes release pressure as rock moves past one another
E	Transform	Earthquakes close to the surface	Two plates are sliding past each other, the earthquakes release pressure as rock moves past one another
F	Convergent (continental-oceanic)	Volcanos, trench, mountains, older oceanic crust, earthquakes deep below the surface	Denser oceanic crust is being subducted under continental curst, causing volcanic mountains to form. Deep earthquakes release pressure.
G	Divergent (continental-continental)	Rift Valley (Red sea has flooded it), volcanos, earthquakes close to the surface	Plates are moving apart, causing new crust to form

Commented [CA8]: These can be a little hard to see on the relief map, they show up as long, thin purple lines.

Commented [CA9]: This one can be a little hard to discern, there's a lot of tectonic data in the Caribbean. Direct students to look at the overall plate motion. There is convergence on the east side and divergence on the west. This could be a bonus or extension question.

Commented [CA10]: These can be a little hard to see on the relief map, they show up as long, thin purple lines.

Commented [CA11]: This is a little challenging to identify because there is divergence on the western side of the Nazca plate with the Pacific plate. The crust of the eastern Nazca plate is young relative to other parts of the world, is older compared to other side, which is where the subduction is occurring.

Commented [CA12]: This is also a challenging identification and could be used as extra credit or extension.

Discussion questions (8pts

1. There are many divergent plate boundaries around the world that create new crust every day, however based off observations, the Earth is not getting any bigger. Explain how over millions of years, the Earth would not expand despite these divergent boundaries.

While new crust is created at divergent plate boundaries, the subduction at convergent plate boundaries melts older crust as it dives into the mantle, which keeps the Earth from continuously growing.___________

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2. The Earth is about 4.5 billion years old, but the oldest sea floor rocks are only about 180 million years old. Why are the rocks on the sea floor not older?

Sea floor rocks are not older because oceanic crust gets subducted and recycled into the mantle at convergent plate boundaries. This occurs because the oceanic crust is usually more dense than continental crust.____

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3. Given what you know about how the surface of the Earth changes, why would it be more useful in identifying plate boundaries to take the age from rocks on the sea floor rather than on land? Explain your reasoning.

Commented [CA13]: Relate this back to the rock cycle, particularly sedimentary rock, and how solid is formed.

Continental crust is exposed to physical and chemical weather and erosion. The rock and soil at the surface usually are not formed where their constituent particles originated. ___________________________________

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4. Given your knowledge of Earth's interior, why are these plates moving? What is driving continental drift?

Convection currents in the mantel drive the movement of the tectonics plates. _________________________

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