**Plate Tectonics**

**I. Introduction**

The [outer layers of the Earth](https://en.wikipedia.org/wiki/Structure_of_the_Earth) are divided into the [lithosphere](https://en.wikipedia.org/wiki/Lithosphere) and [asthenosphere](https://en.wikipedia.org/wiki/Asthenosphere). The lithosphere is cooler and more rigid, while the asthenosphere is hotter and flows more easily. The key principle of plate tectonics is that the lithosphere exists as separate and distinct [tectonic plates](https://en.wikipedia.org/wiki/List_of_tectonic_plates), which ride on the fluid-like asthenosphere. Plate motions range up to a typical 10–40 mm/year ([Mid-Atlantic Ridge](https://en.wikipedia.org/wiki/Mid-Atlantic_Ridge); about as fast as [fingernails](https://en.wikipedia.org/wiki/Fingernail) grow), to about 160 mm/year ([Nazca Plate](https://en.wikipedia.org/wiki/Nazca_Plate); about as fast as [hair](https://en.wikipedia.org/wiki/Hair) grows).

Tectonic lithosphere plates consist of lithospheric mantle overlain by one or two types of crustal material: [oceanic crust](https://en.wikipedia.org/wiki/Oceanic_crust) and [continental crust](https://en.wikipedia.org/wiki/Continental_crust). Average oceanic lithosphere is typically 100 km (62 mi) thick; its thickness is a function of its age: as time passes, it cools and the cooling mantle is added to its base. Because it is formed at mid-ocean ridges and spreads outwards, its thickness is therefore a function of its distance from the mid-ocean ridge where it was formed. For a typical distance that oceanic lithosphere must travel before being subducted, the thickness varies from about 6 km (4 mi) thick at mid-ocean ridges to greater than 100 km (62 mi) at [subduction](https://en.wikipedia.org/wiki/Subduction) zones. Continental lithosphere is typically about 200 km thick, though this varies considerably between basins, mountain ranges, and stable interiors of continents.

The location where two plates meet is called a plate boundary. Plate boundaries are commonly associated with geological events such as [earthquakes](https://en.wikipedia.org/wiki/Earthquake) and the creation of topographic features such as [mountains](https://en.wikipedia.org/wiki/Mountain), [volcanoes](https://en.wikipedia.org/wiki/Volcano), [mid-ocean ridges](https://en.wikipedia.org/wiki/Mid-ocean_ridge), and [oceanic trenches](https://en.wikipedia.org/wiki/Oceanic_trench). The majority of the world's active volcanoes occur along plate boundaries, with the Pacific Plate's [Ring of Fire](https://en.wikipedia.org/wiki/Pacific_Ring_of_Fire) being the most active and widely known today.

Tectonic plates may include continental crust or oceanic crust, and most plates contain both. For example, the African Plate includes the continent and parts of the floor of the Atlantic and Indian Ocean. The distinction between oceanic crust and continental crust is based on their modes of formation. Oceanic crust is formed at sea-floor spreading centers, and continental crust is formed through [volcanism](https://en.wikipedia.org/wiki/Volcanic_arc) through tectonic processes. Oceanic crust is denser because it has less silicon and more heavier elements than continental crust. As a result of this density, oceanic crust generally lies below [sea level](https://en.wikipedia.org/wiki/Sea_level) (for example most of the [Pacific Plate](https://en.wikipedia.org/wiki/Pacific_Plate)), while continental crust buoyantly projects above sea level.

In this activity, you will examine the density, composition, and density of continental & oceanic crust. You will also determine the types of plate boundaries that develop from continental & oceanic crust.

**II. Procedure**

1. Start the activity by going to the following website :

<https://phet.colorado.edu/en/simulation/legacy/plate-tectonics> .

2. IF NECESSARY, click on “Run Now!” and open the JNLP file. If not, just open the

simulator.

3. **Crust**

1. The first page that opens up should have a tab with the headline “Crust”.

2. On the left side of the frame there is a slab of oceaniccrust, and on the right side there

is a slab of continentalcrust. Drag the **Density** meter from the **Toolbox** onto the

oceanic crust so that the arrow at the bottom of the meter points to the light gray section of the oceanic crust. Observe the reading on the density meter. Now move

the density meter over to the continental crust on the far right of the frame and check

the density on the light gray section of the crust.

Is there a difference in the density reading between the oceanic and continental crust?

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Which type of crust is denser? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why is it denser? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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3. Drag the density meter over the middle slab of crust that is not labeled and drop the

density meter on the light gray section. The small arrow at the bottom of the density

meter should be pointing to the light gray area. At the top center of the frame there is

a box labeled “My Crust” with three slide rules (Temperature, Composition,

Thickness). These slides will allow you to change and manipulate the middle section

of the crust that is not labeled. Increase the iron content of the crust by sliding the

**Composition** rule all the way to the left.

What happens to the density when you add more iron to the crust?

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If you change the composition by adding more silica to the crust (sliding the rule to the right), what happens to the density?

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Click the yellow “Reset All” button at the bottom. Drag and drop the density meter on

The middle slab of crust again. If you add heat to the crust by sliding the **Temperature**

rule to the right, what happens to the density of the material?

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What happens to the density of the material if you make the crust cooler by taking away

heat? *(Slide Temperature rule to the left)*

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4. **Plate Motion**

1. Click on the second tab at the top of the frame labeled “Plate Motion”.

2. In the bottom right hand corner of the frame there should be a box with three different

types of crust (Continental, Young Oceanic, Old Oceanic). Click on the **Continental**

crust and drag it over the dashed outline of the crust on the left hand side. Drop the

continental crust when the dashed outline turns yellow/green.

3. Drag and drop the **Old Oceanic** crust on the right hand side of the crust.

4. In the box labeled “View”, check the option “Show Seawater” by clicking on the box

next to the option.

5. Click and hold the green arrow until the plates stop moving and write down what you

observe happening:

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What type of plate boundary is this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What stress force is being applied? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What do you see forming at these boundaries? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. Click the yellow “Reset All” button.

7. Drag and drop **Old Oceanic** crust on the left hand side of the plate boundary.

8. Drag and drop **New Oceanic** crust on the right hand side of the plate boundary.

9. Check the box labeled “Show Seawater”.

10. Click and hold the green arrow until the plates stop moving.

What forms at this boundary?

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How many years did it take for this to form? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If both plates were made of oceanic crust, how is it possible for one of the plates

to slide under the other? Explain.

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11. Click the yellow “Reset All” button.

12. Drag and drop **Continental** crust on the left hand side of the boundary.

13. Drag and drop **Continental** crust on the right hand side of the boundary.

14. Click and hold the green arrow until the plates no longer move.

What forms at this boundary?

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Where on our planet can we see this happening? (Hint: Think Mt. Everest)

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Why are there no subduction zones at this boundary?

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15. Click the yellow “Reset All” button.

16. Drag and drop **Continental** crust on the left hand side of the boundary.

17. Drag and drop **Continental** crust on the right hand side of the boundary.

18. Check the box next to the label “Show Seawater”.

19. Click and hold the red arrow until the plates no longer move.

What type of plate boundary is this?

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What stress force is being applied?

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What is created at this type of boundary?

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Where on our planet can we find this type of boundary? (Hint: Think oceans)

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Name and describe the process that is occurring underneath the crust that allows

new crust to form.

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20. Click the yellow “Reset All” button.

21. Drag and drop **Continental** crust on the left hand side of the boundary.

22. Drag and drop **Continental** crust on the right hand side of the boundary.

23. Click and drag the blue arrow until the plates no longer move.

What type of boundary is this?

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Movement of the plates at this boundary causes what type of natural phenomenon?

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Where on our planet can you find this type of boundary? (Hint: Think faults)

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