Earthquakes and Plate Boundaries

Exploring the theory of tectonic plates

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Inspired by Dudley Friskopp lesson

Background

Tectonic plates surround the Earth and makes up the lithosphere (crust). Each plate moves in its own direction due to the convection currents that exist inside the mantle. This movement leads to plates either moving away from each other, or moving against each other. We can use Earthquake data to identify the locations of where the plates meet because Earthquakes can be a result of movement at and between plate boundaries.

Additional Resources

- *Introducing the International Ocean Discovery Program*
  - https://www.youtube.com/watch?v=0nydKlpZdIU&list=PLroDmZEKRHPMCtFMzjx-Zg7plqnIqWMjI&index=2&t=242s
- *How Science Works*
  - https://www.youtube.com/watch?v=i9tsdAQBcfM&list=PLroDmZEKRHPMCtFMzjx-Zg7plqnIqWMjI&index=3&t=0s
- *PNN Special Report Life on Board*
  - *https://www.youtube.com/watch?v=n0bcIoALDFg&list=PLroDmZEKRHPMCtFMzjx-Zg7plqnIqWMjI&index=4&t=341s*

Activity Summary

Students will be able to identify the lines of Latitude and Longitude on a map and then determine coordinates of any location pointed out on a map. That skill will directly connect to reading coordinates to determine positions of Earthquakes around the world. Students should make observations of the positions of Earthquakes on the map and determine the connection with tectonic plate boundaries.

Next Generation Science Standards

HS-ESS1-5.	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks

College and Career Readiness Standards for Adult Education

CCR Anchor 7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

Target Audience

Adults English Language Learners getting High school diploma or equivalency (in science classes)

Time Required

~ 1.5 hours

Materials Needed

- A semi- large paper world map (without the tectonic plates)
- The same map printed on a smaller scale for everyone to have one version
- 100 + drawing pins (pins with large plastic heads)

Links referenced:

Sciencing: https://sciencing.com/read-longitude-latitude-5083052.html
Encylopaedia Britannica: https://www.britannica.com/science/latitude
Owlcation: https://owlcation.com/stem/The-History-of-Plate-Tectonics
The puzzle of plate tectonics blog: https://joidesresolution.org/the-puzzle-of-tectonic-plates/

Lesson Description

- Hold up the globe or map of the world and ask students what they see and what they recognize. Have them point out where they are from and where they are now. Review the names of each continent.
    - Print out a smaller map for everyone to have as their own handout.
- Have them observe the lines that run from the top to the bottom of the globe and from left to right. Introduce the words latitude, longitude, and equator.
    - *Lines of longitude and latitude are imaginary lines used for measuring locations on Earth.*
    - Move to the **equator** and have the students observe what places it crosses. Ask them what they know about those places. You can discuss that those places are mostly hot year-round. Then say that the equator is the starting line for all the other horizontal lines; it is given the number 0. Each line represents a number.
        - Have students trace the Equator with one color (highlighter, colored pen, or colored marker)

    - Connect it to **latitude**. Say that latitude are the lines that are north or south of the equator. Latitudinal positions are the lines drawn in circles parallel to the equator. The units are in degrees, minutes, and seconds. This is how we get the names for

a Northern Hemisphere or Southern Hemisphere. Hemisphere means half of a sphere, and the sphere in this case is the Earth.

- Move to **longitude.** Say that longitude is the lines that are east or west of the prime meridian. The prime meridian is a longitudinal line that is the "zero" of all the lines that run vertically across the globe. The units are in degrees, minutes, and seconds. Show the image below.
    - Have students trace the prime meridian with one color (highlighter, colored pen, or colored marker)
    - Show image below

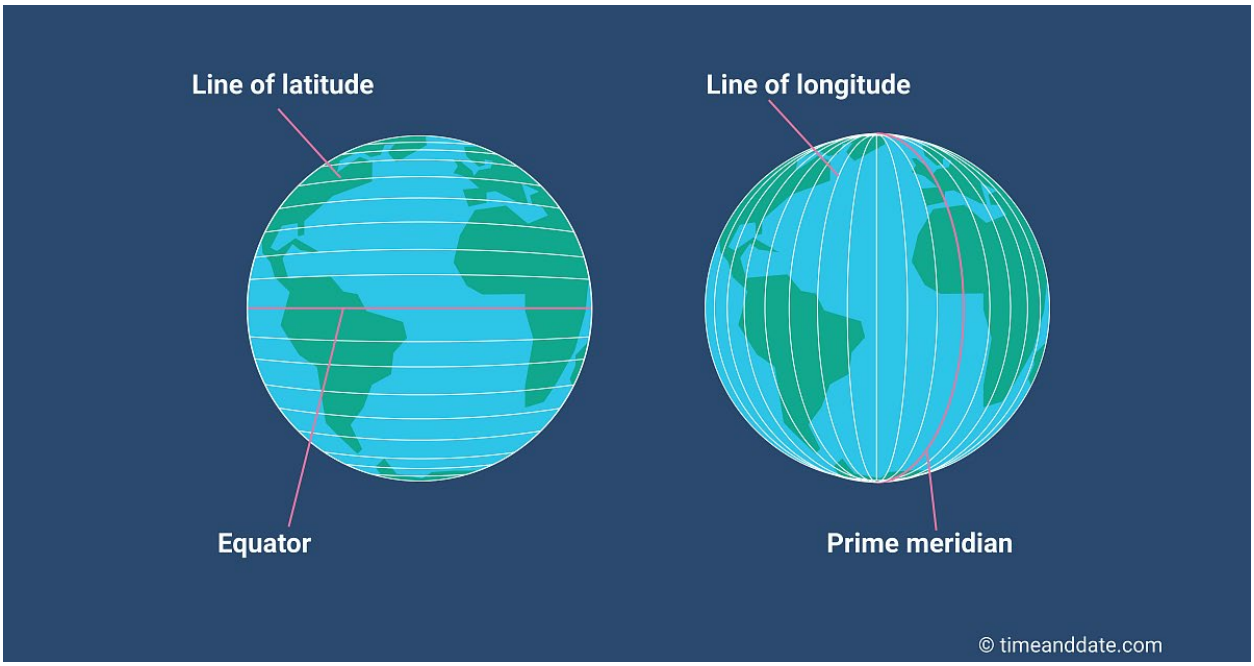

Image credit: https://www.timeanddate.com/geography/longitude-latitude.html

- Now practice finding where a latitude line and a longitude line intersect. Have students choose a point on the globe or map you started with.

- After everyone finds different latitude and longitude lines crossing at different locations, then say *Each point has **coordinates** that are in degrees, minutes, and seconds. Once we find where they intersect we can learn the coordinates of the location. Let's learn about the numbers associated with each of the Latitude and Longitude lines.* Show the image below.

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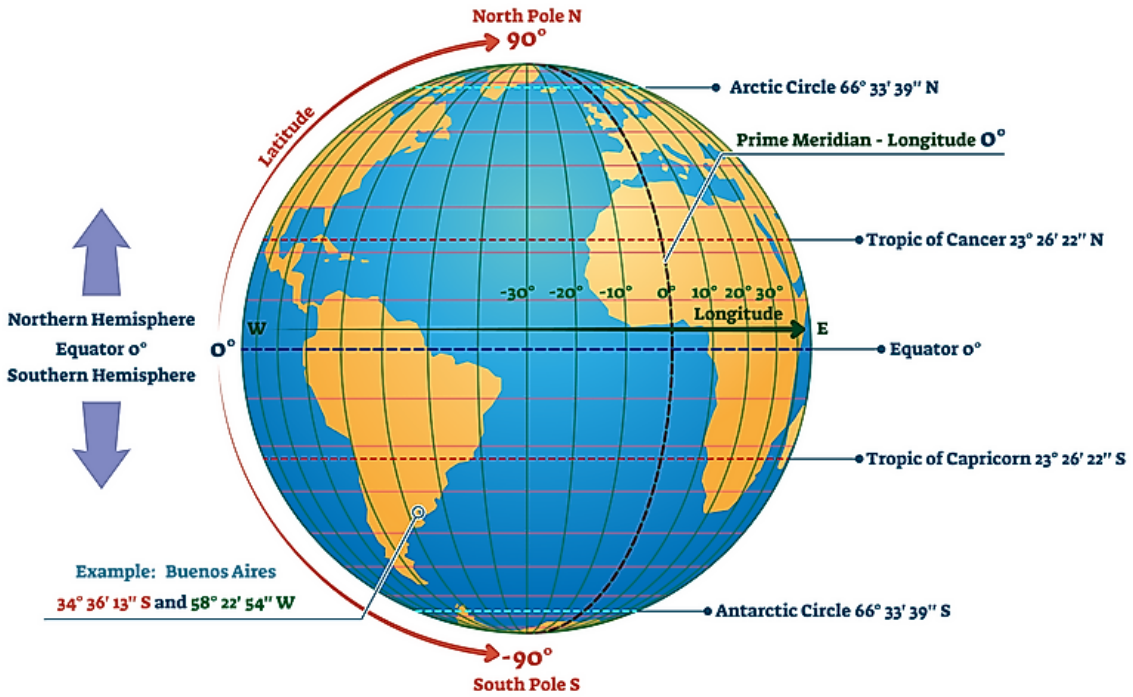
EQUATOR
LATITUDE AND LONGITUDE



- Example from Sciencing: For instance, an area with coordinates **marked 41° 56' 54.3732" N, 87° 39' 19.2024" W** would be read as 41 degrees, 56 minutes, 54.3732 seconds north; 87 degrees, 39 minutes, 19.2024 seconds west.
  - N stands for north, W stands for west
  - North indicates that it lies north of the Equator and West indicates that it lies to the West of the Prime Meridian. All coordinates relate to a point on the Earth in relation to these two main lines – the Equator and the Prime Meridian.
  - NOTE: If using just a globe or map, then you can only do the degree reading. The minutes and seconds are the more specific part of the location that differentiates between things meters apart. (You need a GPS system to do that—what Google Maps does for us.)

- As a group, find the coordinates for each of the locations the students pointed to on the map.

Now ask the group: *what are some situations we can use coordinates ?*

Examples: Flying airplanes, sailing a ship, Google Maps, etc..

There is one more thing we actually use coordinates as a way to record locations of Earthquakes. Scientists want to know the most exact spot that Earthquakes happen to understand when, and how they started.

Earthquakes are monitored by using a machine called Seismometer. Scientists that study Earthquakes have put seismometers all over the Earth's surface so they can record any shaking that is felt in the ground.

Let's work together to see where earthquakes are happening in the world.

Divide students into groups (depends on how many students you have)

- Share the Excel spreadsheet you created (following instructions below) and ask students to practice finding the locations of the earthquakes using what we learned about coordinates.
- Tell the students to place a drawing pin on the map where the earthquake happened. Have students work on the same big map. After a while, you should see specific lines of pins showing up.
- Once everyone puts their pins down, have everyone look at the map together.
- Then ask: what do you notice about where these pins are showing up?
    - Should get answers about the Earthquakes happen around each other and some fall on a certain path or line
- Ask :What do you think is causing these Earthquakes only in those places?
    - *Take some answers*
- *Ask: We used earthquake data for 7 days, but what do you think would show up if we used more than just 7 days?*
    - *Answers of getting more Earthquakes, more of them in the same places.*
- Show the Earthquake data website where you initially got the data for the activity but now change the time frame to be a month. Have students observe how much more shows up on the map.
    - Ask again: *what do they notice about the places with Earthquakes? Do their ideas of what's causing them change?*

These locations of Earthquakes is showing you tectonic plate boundaries!

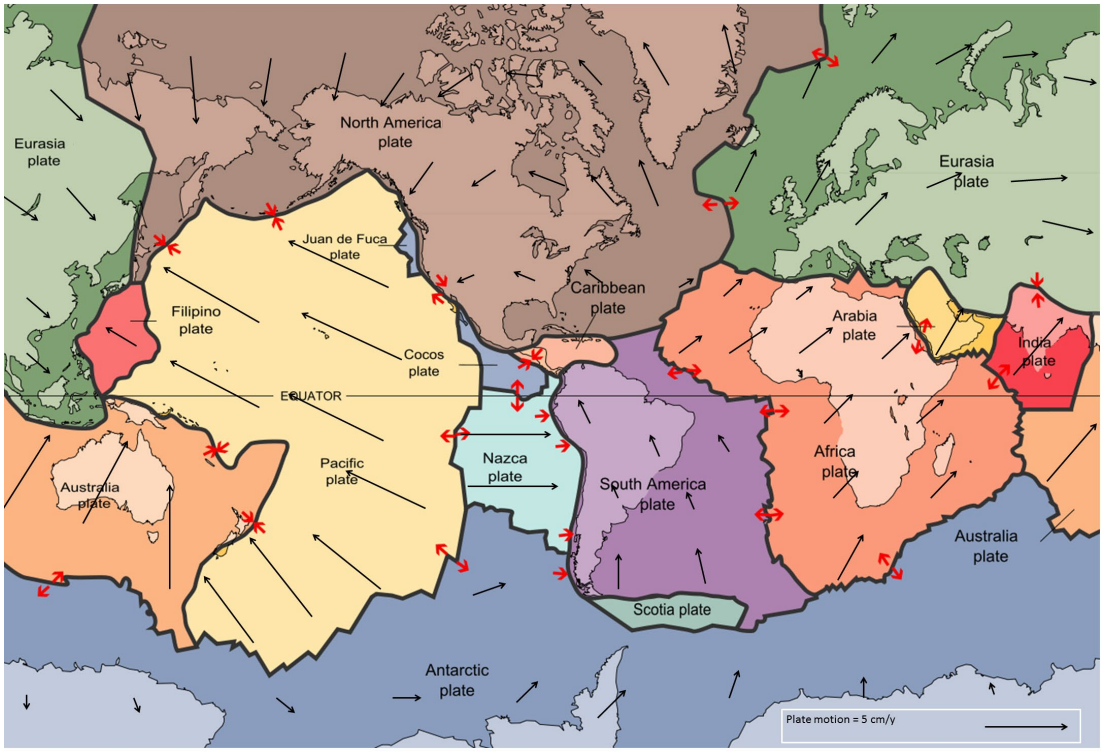


Image credit: https://opentextbc.ca/geology/chapter/10-4-plates-plate-motions-and-plate-boundary-processes/

- *The continent is made of rocks (different kinds of rocks). The large pieces of rock that cover the earth are called the crust or lithosphere, and the crust comes in pieces called tectonic plates.*
    - *Compare the Earthquake data to this map, where do the Earthquakes happen?*
        - *Where the plates meet and push against each other. We call these the Tectonic plate boundaries*
        - *Example: Nazca plate and South American Plate*

- Can say: *If an earthquake happens underwater can cause a tsunami! We used earthquake data for 7 days, but if we used more than just 7 days we would see more of them along the plate boundaries. This helps us understand that there is movement of the plates against each other and that Earth's crust is in pieces.* ***

Exit ticket:

- What is one thing you want to know more about?
- What is one thing you learned?

From the answers you can see about what they want to know more about, and use that as a way to review the next time you meet. Look for any material that can provide them the answers for their questions.

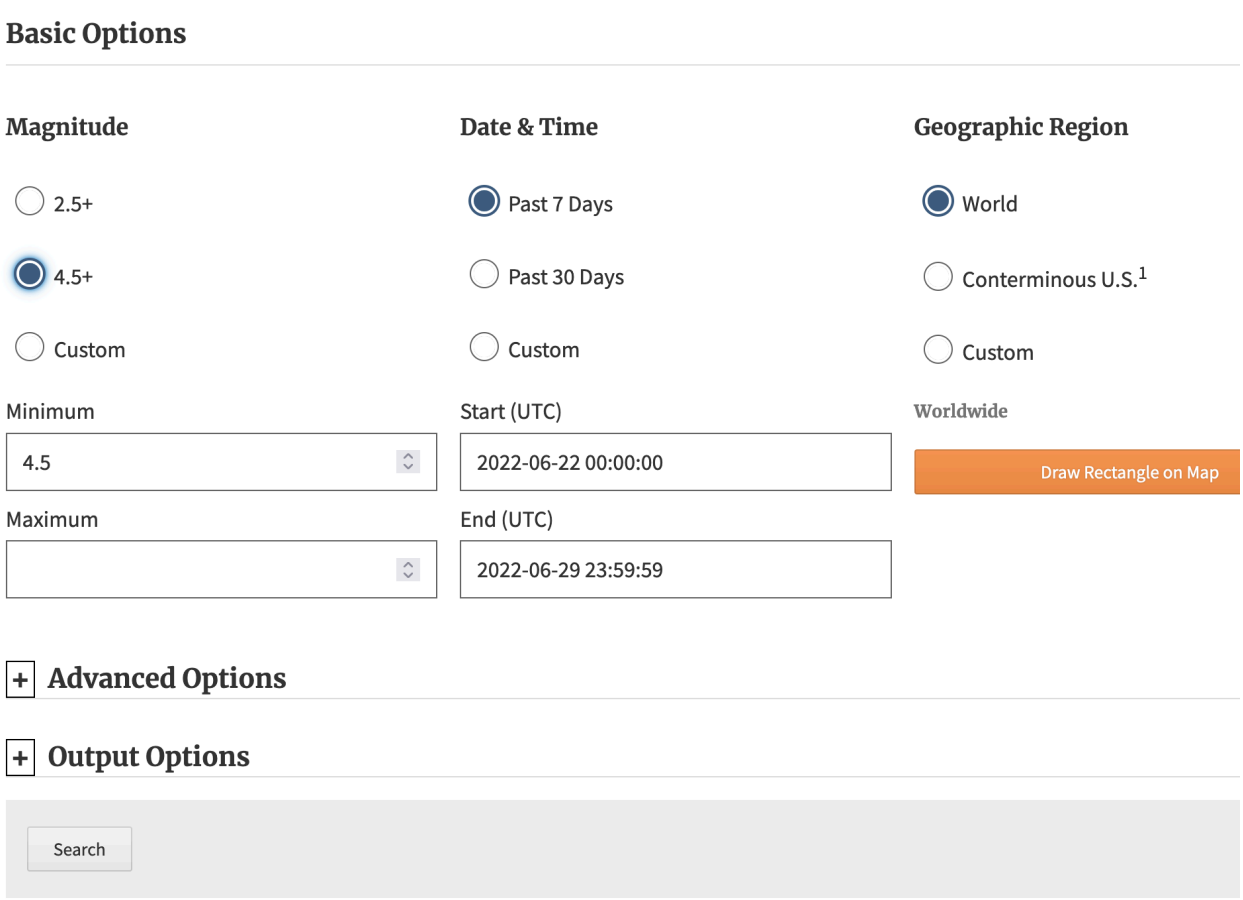
Summary:

- Latitude and longitude are ways to measure Earth and create coordinates to pinpoint certain locations on Earth.
- You can use locations of earthquakes to identify the location of tectonic plate boundaries.
- Earth's crust (the lithosphere) is split up into plates that can either pull away from each other or grind against each other, causing earthquakes.

How to obtain earthquake data

Go to this link: https://earthquake.usgs.gov/earthquakes/search/

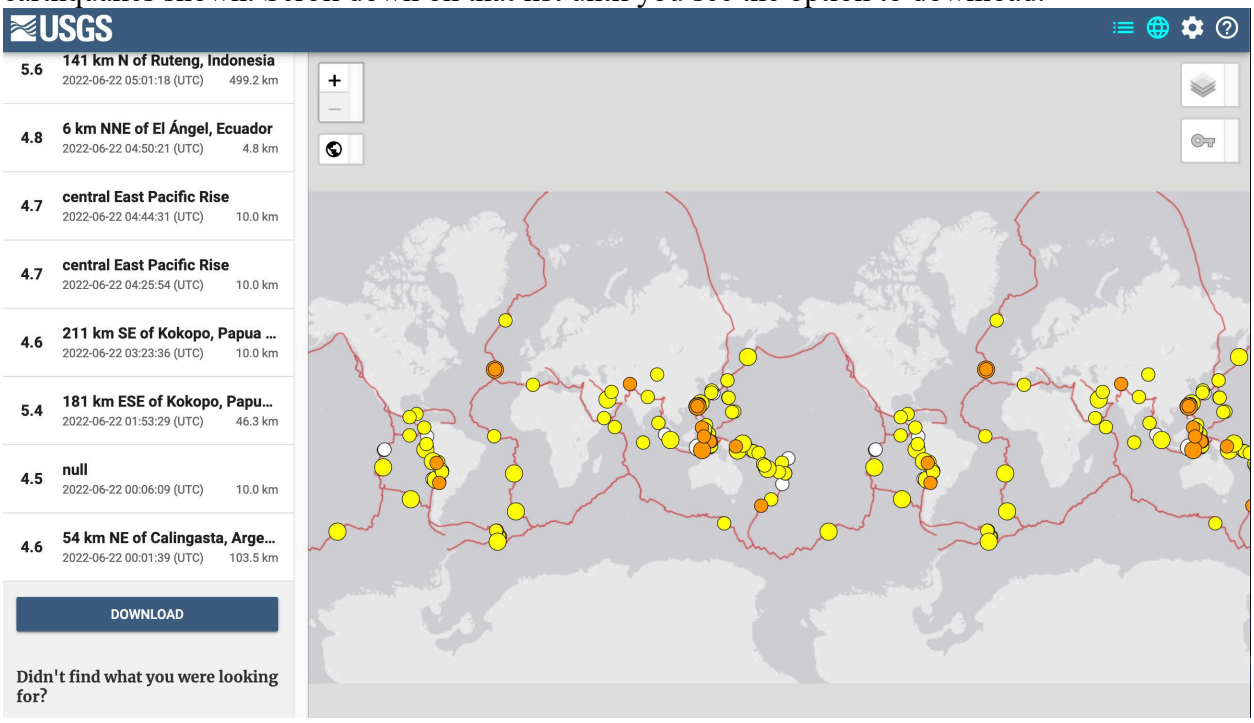
You will be given an option to customize your search. Choose the option magnitude 4.5+ and then keep it on World. Make sure the date and time search is for the past 7 days minimum, or you can do more.



(The start and end dates on this photo are just for the past 7 days for when this screenshot was taken. It is ok if your dates are different.)

Click the option to search, and a map should show up with points of impact of each earthquake.

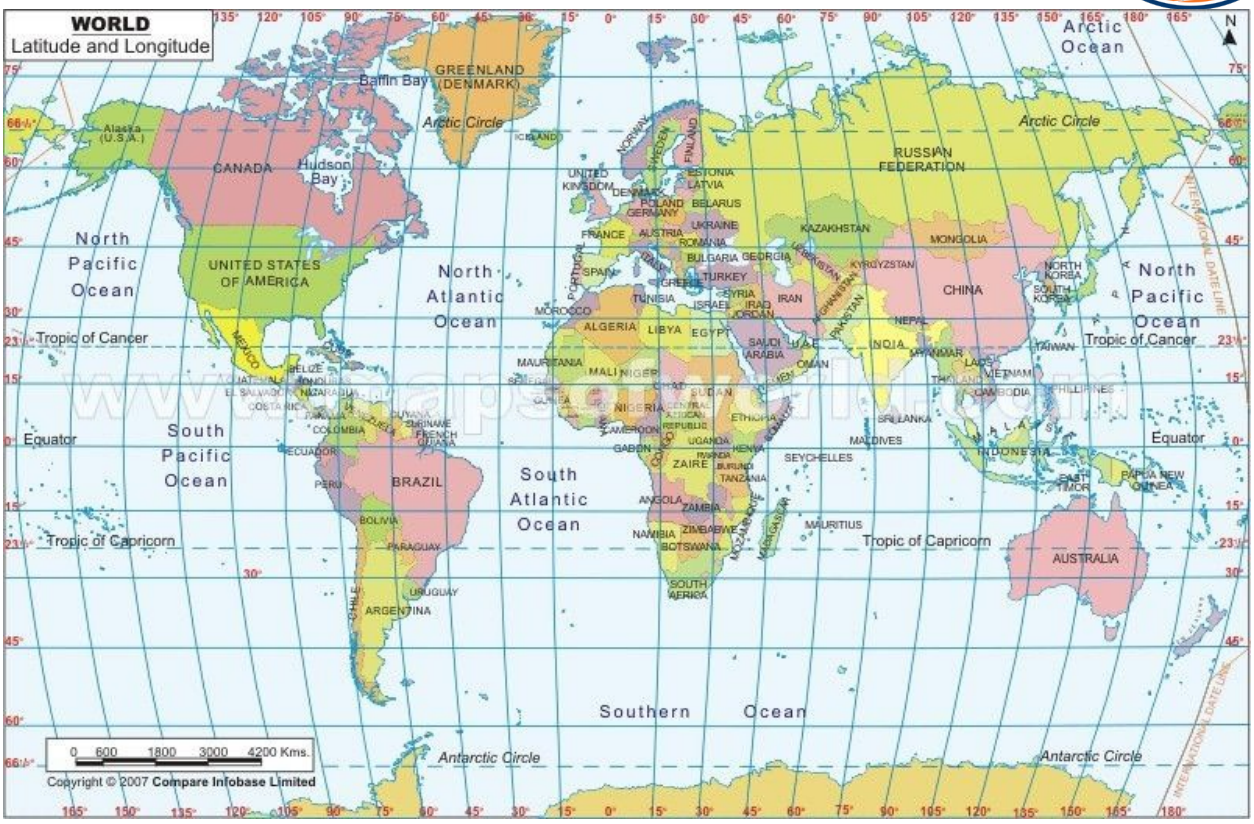
Your window should then show you a world map, with the tectonic plates drawn on and dots showing earthquake events. On the left side of that window, you should see a list of all the earthquakes shown. Scroll down on that list until you see the option to download.



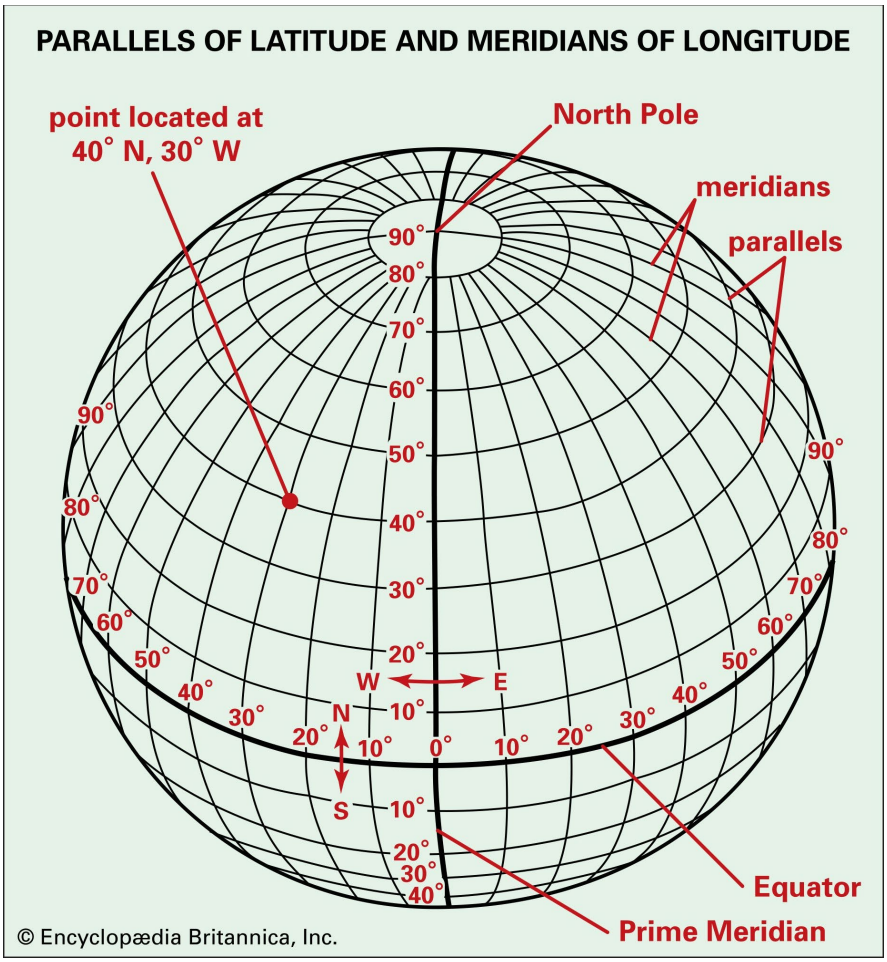
Click Download to CSV. This will provide you with an Excel spreadsheet.

From that Excel spreadsheet, make separate sheets with the latitude and longitude coordinates into 3 – 4 groups. This will be the 3 – 4 different lists for groups of students to work with.

Additional images:



Additional image 1



Additional image 2

*****If you have extra time you can do an observational activity with the tectonic plate image and the convection currents of the magma just below the crust OR you can use this to begin your next class:**

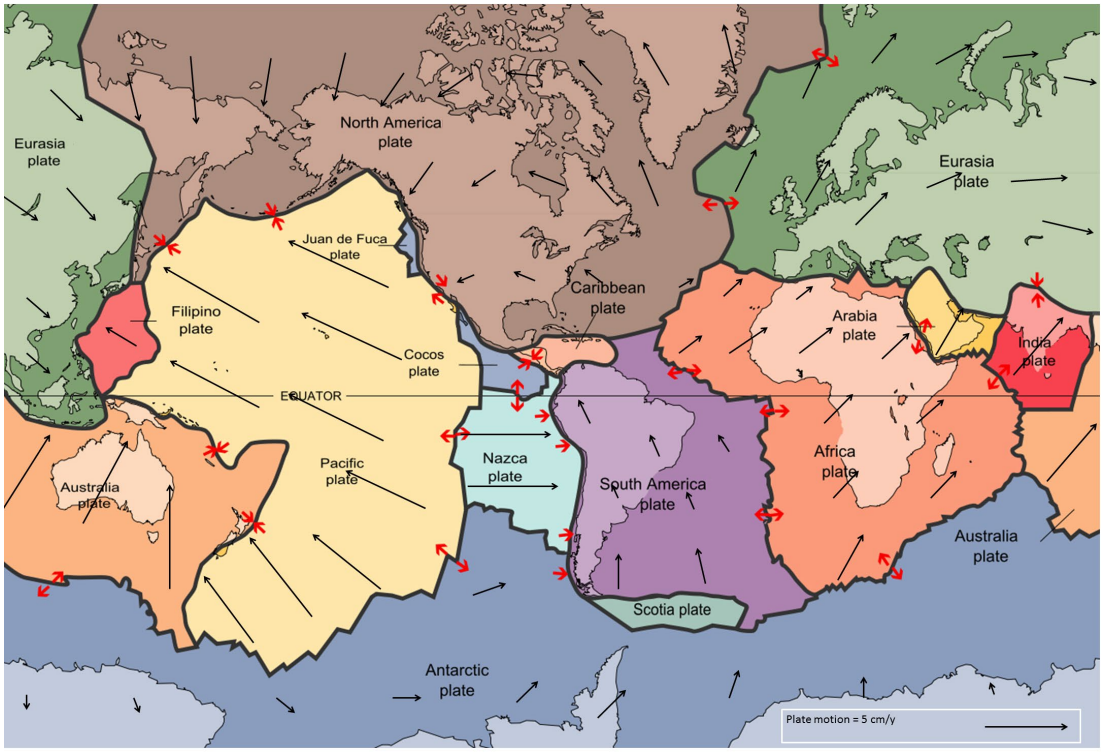
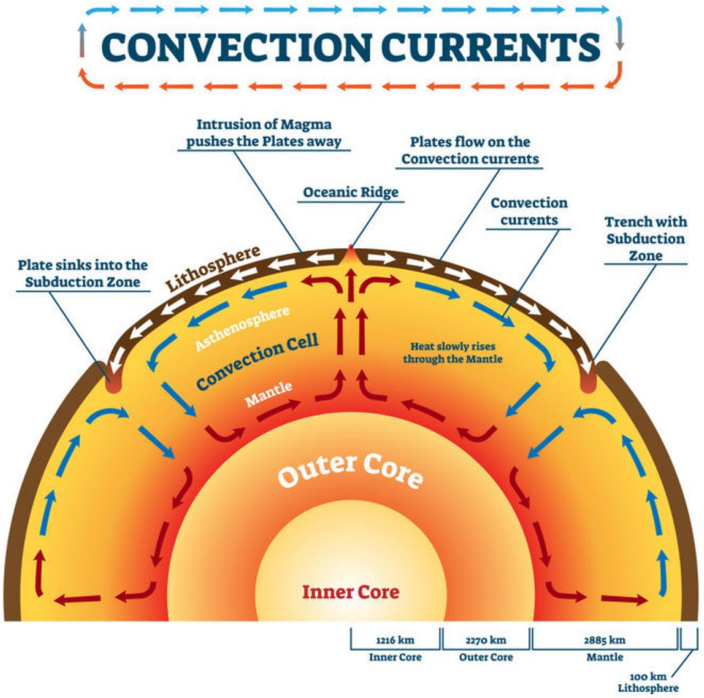


Image credit: https://opentextbc.ca/geology/chapter/10-4-plates-plate-motions-and-plate-boundary-processes/

- Ask students: *What do you notice about this image?* (Point out colors, arrows, and hard lines dividing the pieces.)
- *Where do the continents and the seafloor share the same plate*? (South American plate, African plate, Australian plate…etc.) *Where on the map is there is no continent sharing the same plate?* (Pacific Plate, Nazca Plate—there may be small islands on these plates, but for size comparison we will say there aren't big continents.)
- *If the map is showing us the pieces of rock that we call plates, what do you think the arrows are showing us*? (Hopefully, you get answers of movement, direction.)
    - *The arrows are showing us the movement of the plates! They are always moving because the inside of the Earth is like a big bowl of hot rock soup being stirred!* Show image below.
- *The center of the Earth is what you can think of has a big bowl of hot rock soup. It is so hot we get liquid rocks that are called magma. It is what you can think of that comes out of Volcanoes. That magma started out inside the Earth and when it comes out of the Volcano it is called lava.*



- Show the above image. *The movement of the plates is due to the magma under the layer of rocks moving and pulling the plates along the surface. The plates are a part of something called the Lithosphere (the part of Earth that is rock). Take your time to observe this image. What do you notice about colors, arrows, and labels?*
    - They should see different colors arrows (blue for cooler magma, and red for hotter magma), they should see labels for each part, distance of each layer..etc
    - For question about convection : Convection is defined as the flow of fluid where cooler parts of the fluid will sink and warmer parts will rise causing it to circulate in the are (we see this when we boil water).
    - Take your time walking the students through this image emphasizing the lithosphere is moving in the same direction as the cooler magma moves.
- Focus in on what is happening to the lithosphere. Ask *what do the labels say about the lithorsphere?*
    - Subduction: a heavier plate will sink under a lighter plate causing it to melt and be recycled into the mantle as magma. A lighter plate is less dense.
- Then focus in on what is happening to another part of the lithosphere. Ask "*what do you think is happening at the Oceanic Ridge?"*
    - Oceanic ridge is where the plates are moving away from each other creating a space for magma to escape. This creates new fresh crust.
- Then on the world map, find where there is a subduction zone between two plates. Find where there is an oceanic ridge. Ask students *where they think a subduction zone is and an oceanic ridge is* (Pay attention to the arrows of the lithosphere and the plates.)
    - Should point out mid-Atlantic Ridge, and a subduction zone between the Australian plate and Pacific plate.
- *What do you think happens when the plates subduct or grind against each other*? *Do you think they move over each other smoothly?*

- Do we feel it?
- Yes! Earthquakes!