

Classroom Activity

10 Big Question: How does the earth work?

Explore plate tectonics and recent earthquakes

Another violent result of tectonic plate movement is earthquakes. The United States Geological Survey provides a site as part of their Earthquake Hazards Program which maps the tectonic plate boundaries and onto this, projects earthquakes (with magnitude > 2.5) that occurred around the world in the last week. In this activity, you can use this map to explore plate tectonics and earthquakes from the comfort (and safety) of your computer!

Before you begin, take a look at the following page to determine which plate boundaries are subduction boundaries (these are marked as convergent boundaries on the map, and mid-ocean ridges as divergent plate boundaries):

[+] <https://www.geolsoc.org.uk/Plate-Tectonics>

To get started, go to the mapping website (you'll get the best out of it on a desktop):

[+] earthquake.usgs.gov/earthquakes/map/

Here you will see a map of the globe with the tectonic plate boundaries and the earthquakes from the last week. You can plot past earthquakes using the archive. Go back over as many weeks as you wish and create a list noting the magnitude (M) and depth of the earthquake's source (D). Using the tectonic plates map decide if each earthquake occurred on a subduction boundary or oceanic rifts (mid-ocean ridges).

What did you find? What type of boundary causes earthquakes that are deeper than 100 km?

For those looking for an extension:

Assuming the length of the equator on this map is approximately 40,000 km, roughly measure how long the total length of subduction boundaries there are on the planet at present using a printed plate boundary map and a piece of string or cotton (this will be very rough as the map is a distorted projection). Using this type of map projection, lengths are increasingly over estimated the further they are from the equator. To make a rough correction for this distortion, multiply the rough length measurement you took by 0.6.

Assuming that:

- The average content of water in the subducting slab is 400 parts per million (ppm)
- The subducting plate is 100 km thick with a density of 3 grams/cm³
- The rate of subduction is 15 mm/year
- The ocean has about 1.35×10^9 km³ of water (a cubic kilometre of water weighs 10^9 tonnes, so this equals 1.35×10^{18} tonnes)

What is your estimate in tonnes (1 tonne = 1000 kg) of water that is subducted globally each year? If only 80% is returned to the surface by volcanic processes how long will subduction take to dry up the oceans? (Hint: You may need to convert some units so they are common.)

Explanation of the calculation:

Start by working out the mass of oceanic lithosphere that is subducted each year. Here is how to do that:

Mass of oceanic lithosphere subducted per year = length of subduction (km) x thickness of plate (km) x annual rate of subduction (km/year) x density (tonnes /km³)

To determine the weight of water subducted per year, multiply the total weight of annually subducted lithosphere by its weight fraction of water (ppm is a concentration value, so as a fraction 400 ppm is 400/1000000):

Mass of oceanic lithosphere subducted per year (from step 1) x (400/1000000) = the weight of water subducted per year