STEM IN THE LAB

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Idaho National Laboratory

EARTHQUAKE EDUCATION

The Earth sits on big sheets of soil or land called plates, and these plates move and shift from time to time. This moving plate system that makes up all the crust of the globe, even under the oceans, is called plate tectonics. How and why it works are good questions that are a lot of fun to explore!

At Idaho National Laboratory, nuclear power plants are designed to avoid earthquake damage.

GRADE LEVELS: 4-9

VOCABULARY

Earthquake *– a sudden and violent shaking of the ground, sometimes causing great destruction, as a result of movements within the Earth's crust or volcanic action.*

Plate Tectonics *– a theory explaining the structure of the Earth's crust and many associated phenomena as resulting from the interaction of rigid lithospheric plates which move slowly over the underlying mantle.*

An Earthquake Fault *– a fracture along which the blocks of crust on either side have moved relative to one another parallel to the fracture, including strike-slip, normal and reverse faults. A reverse fault with a small dip angle is a thrust fault.*

Seismograph *– an instrument that measures and records details of earthquakes, such as force and duration.*

Epicenter *– the point in the crust where a seismic rupture or earthquake begins. The point of highest energy, where the earth shakes the most.*

Seismologist *– a scientist who studies earthquakes and their phenomena.*

Nuclear Power Station *– A group of buildings that house a nuclear reactor, heat exchangers, cooling system, and electrical generators to make electricity for homes and businesses.*

Earth's Crust *– a thin shell on the outside of Earth, accounting for less than 1% of Earth's volume. It is the top component of lithosphere: a division of Earth's layers that includes the crust and the upper part of the mantle. The lithosphere is broken into tectonic plates that move, allowing heat to escape from the interior of the Earth.*

The crust lies on top of the mantle, a configuration that is stable because the upper mantle is made of peridotite and is significantly more dense than the crust. The boundary between the crust and mantle is conventionally placed at the Mohorovičić discontinuity, a boundary defined by a contrast in seismic velocity.

The crust of Earth is of two distinct types:

1. Oceanic: 5 km (3 mi) to 10 km (6 mi) thick and composed primarily of denser, more mafic rocks, such as basalt, diabase, and gabbro.
2. Continental: 30 km (20 mi) to 50 km (30 mi) thick and mostly composed of less dense, more felsic rocks, such as granite.

Because both continental and oceanic crusts are less dense than the mantle below, both types of crust "float" on the mantle. This is isostasy, and it's also one of the reasons continental crust is higher than oceanic: continental is less dense and "floats" higher. As a result, water pools above the oceanic crust, forming the oceans.

MATERIALS

(Younger students Lab)

- Graham crackers
- Notebook paper
- 2 large full sheets of paper towels

(Older students Lab)

- A 1 by 2 foot piece of cardboard
- Notebook paper
- Uncooked spaghetti noodles
- Big or small marshmallows

PROCEDURE

First, view the following video- https://www.youtube.com/watch?v=yBr-D1cFmEs

There are two labs: one for younger students and one for older students, both show very similar ideas. Younger students will need more parental help to do the older lab.

LAB (younger students)

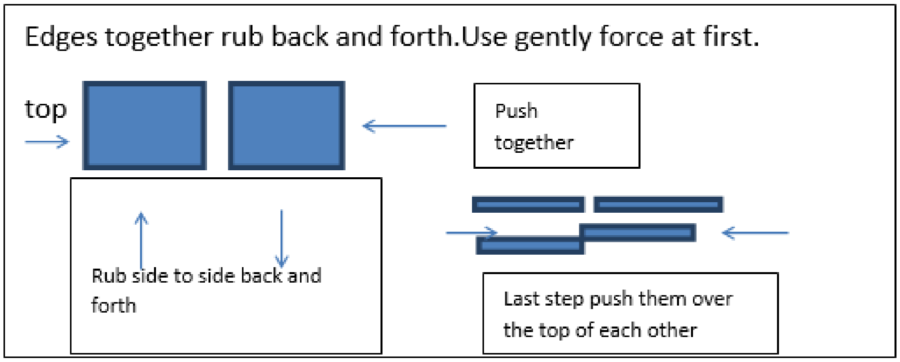
1. Lay out the paper towel in one big sheet on your counter or floor.
2. Carefully break a large graham cracker (a whole cracker) in half with as straight an edge as possible. Each half is one tectonic plate. When earthquakes happen, two plates of the Earths' crust rub against each other and cause the earth to shake, it only happens for a short time. Use a sheet of notebook paper and make a chart with 6 rows down and 4 columns across to record your results.

3. *Now, holding the two cracker halves with one in each hand a little bit above the whole paper towel, gently touch the two edges that were broken apart of the crackers together for 1 second, rubbing the edge of them once together side to side. Now observe the amount of graham cracker that has fallen off and record it on your lab notebook paper. Gently dump the crumbs off the paper towel as best to clean it.*
4. *Again, put the edges gently together and rub them for two seconds, two times side to side, observe the amount and record it on your lab report chart. Clean the paper towels each time you do one of the experiments.*
5. *Put the edges together so they touch, this time rub them for 3 seconds (1001, 1002, 1003). Observe the amount and the size of the pieces that have fallen onto the paper towel. Record amount and size on your lab report. Clean paper towel.*
6. *This time as you rub the edges together, push the cracker toward each other slightly. Not too hard so they break and not so soft that they stop touching each other, but just a little force toward each other. Record and clean paper towel.*
7. *Rub the edges together and push them so that one edge goes up on the other cracker. Record and clean everything up (you can eat the cracker now if you want!)*

LAB (older students)

1. *Cut the cardboard in half, next cut one half in 2 pieces with a smooth (straight) edge between them. Then, cut the other half with an irregular edge that curves back and forth like a wave.*
2. *Each piece is one tectonic plate. When earthquakes happen, two plates of the Earths' crust rub against each other or pull apart from each other and cause the Earth to shake, it only happens for a short time. Use a sheet of notebook paper and make a chart with 6 rows down and 4 columns across to record your results.*
3. *Now, holding the two halves that match, one in each hand, gently touch the two edges that were cut apart together. Move them against each other for 2 seconds, rubbing the edges that touch back and forth and side to side with a slight pressure toward each other. Observe the amount of damage to the edge that occurred as they were moved against each other and record it in your lab notebook paper. Take the two that have the irregular edge and do the same thing. Move them back and forth with slight pressure toward each other for 2 seconds, then observe edge damage and how it was more difficult with the wavy edge to keep them steady. Record observation of test one (first row) 2 columns for each edge.*
4. *Test 2- Put the edges gently together and rub them for four seconds, side to side. Observe the amount of damage and record it on your lab report chart. Test the second wavy edge in a similar way with length of time and pressure. Record on row 2.*
5. *Test 3- Put the edges together so they touch with a little more pressure, this time rub them for 6 seconds (1001, 1002, 1003, and so on). Observe the amount damage. What is happening as the time and pressure go up?*
6. *Test 4- This time as you rub the edges together, push the edges toward each other with slightly more pressure. Not too hard so they break up the cardboard and not so soft that they stop touching each other's edge. Record damage to both edges.*
7. *Test 5- Rub the edges together and push them so that one edge goes up on the others edge. Record the results.*
8. *Test 6- Try one smooth edge and one rough edge together to see the difference it makes. Record the damage and other observations.*

9. Make some structures out of the noodles and marshmallows. Take 3 or 4 short noodles (1 to 2 cm) long and stick them into the same side of the marshmallow so that the marshmallow will stand up on the noodles. Make two or three short buildings and make 3 or 4 taller buildings (apartment complexes or office buildings) 4 to 7 cm. high. Make them so they can stand up on the noodles with the marshmallow on top. Place the two halves of the cardboard flat on a table stand and the buildings on the cardboard. Slide the edge of the cardboard (the fault) back and forth gently. Record what happens to the buildings. Now, with more force on the two plates toward each other, side them back and forth a few times. You may have to stand the building up after the first test. Record results.



EXTENSIONS

Lab questions and conclusions (younger students)

1. *What happens as the earthquake went longer? 1 sec. then 2 sec. then 3 sec.?*
2. *What happens to the size of the pieces coming off the cracker as you rubbed longer and applied more force together?*
3. *If you had something sitting on the cracker as you rubbed them together, what do thing would have happened to it?*

Lab questions and conclusions (older students)

1. *What happens to the edge of the fault as the time and pressure increase? Explain.*
2. *What happens when the edges are forced together hard enough to push the edges up on each other? Explain.*
3. *What changes were seen when buildings were added?*

- *You could add taller structures*
- *You could add salt to the sides of the cardboard to represent loose rocks, marbles as cars, etc.*
- *What else could you use to represent things on the Earth's plates during an earthquake?*
- *What other motions could you simulate in this example?*

RESOURCES

This video is wonderful for both plates of the Earth and how the plates fit on the globe and move around the globe-
https://www.youtube.com/watch?v=RtovoPpHKlQ

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