



***Celebrating Science: Earthquakes Rock Our World***  
**Grade: K-4**

**Description:**

Earthquakes have been rocking our world for the last several billion years, and yet the study of seismology has only really started making advances in the last 50 years, with the theory of plate tectonics. We still can't predict earthquakes, but we know a lot more about how and why they happen. By participating in this Passports exploration, students will understand that earthquakes happen in specific locations and are caused by the interaction between earth's plates. They will know the three different types of plate boundaries and the three different types of earthquakes faults.

**Preparation for the Excursion**

To ensure the most meaningful learning experience for your students, it is recommended that students engage in activities prior to the excursion. The additional resources and activities offer opportunities for curricular connections and integration within your larger unit of study. The excursion is intended to complement a comprehensive unit.

**Challenge Questions:**

- Where do earthquakes happen?
- Are all earthquakes the same?
- Do plate boundaries match continent-ocean boundaries?
- Which plates are almost all land? Almost all ocean? A combination of both?
- Match the different types of faults with the plate boundaries that cause them.

**Responses/Prompts:**

- Earthquakes happen along plate boundaries, where the earth's plates are interacting with each other.
  - Prompts: Do they happen everywhere or in special locations? (special locations) Do they mostly happen all over the plates, in the middle of the plate or on the edges? (on the edges)
- There are three types of earthquakes: normal, reverse and strike-slip. Strike-slip earthquakes tend to be the shallowest and usually don't happen below 20 km. The deepest earthquakes are reverse earthquakes, these happen in subduction zones and can happen at depths down to 700 km in some locations. Normal earthquakes cause crustal extension – more land. Reverse earthquakes cause crustal shortening – less land. Strike-slip earthquakes don't affect the amount of land. Land moves up and down in normal and reverse events and back and forth for strike-slip events. Almost all earthquakes are located along plate boundaries, others are located at hot spots, and a very few happen in the middle of plates. All earthquakes are caused by movement of ground on one side of the fault relative to land on the other side. All earthquakes generate waves. These waves differ in size depending on the earthquake, but each earthquake will have P-waves, S-waves and Surface waves. The bigger the earthquake, the longer the fault.

- Prompts: Do all earthquakes make waves? (yes) Do all earthquakes happen in the ocean? (no) on land? (no) Do all earthquakes happen in the same place? (no) Do different types of plate boundaries cause different types of earthquakes? (yes) Are some earthquakes bigger than others? (yes)
- Plate boundaries do not match up with continent-ocean boundaries. While the Ring of Fire in the Pacific does tend to follow this pattern, this is just a coincidence. Examples of Continent-Continent boundaries: Iceland, New Zealand, India, Southern California; Ocean-Ocean boundaries: along mid-ocean ridge in middle of Atlantic ocean, between the Nazca and Pacific plate, between the Juan de Fuca plate and the Pacific plate; Ocean-Continent boundaries: west coast of South America, Japan, Alaska.
  - Prompts: Use the above examples and point them out on the plate boundary maps
- Almost all land plates: India, Saudi Arabia; Almost all ocean plates: Pacific, Nazca, Cocos, Juan de Fuca, Antarctic, Caribbean, Phillipines, Scotia; Combination of both: North American, South American, African, Asian, Australian
  - Prompts: Use the above examples and point them out on the plate boundary maps
- Divergent Plate Boundary – Normal Faults  
Convergent Plate Boundary – Reverse Faults  
Transform Plate Boundary – Strike-slip Faults
  - Prompts: Do divergent plates move towards each other, away from each other, or slide past each other? (away) convergent? (towards) transform? (slide past) Does land across a normal fault move away from each other, towards each other or past each other? (away) reverse? (towards) strike-slip? (slides past) Use the fault block models and the plate boundary maps to help model the motion.

**Lesson at a glance:**

Students will learn that the earth is made out of pieces like a puzzle. They will explore how the plates move and interact with each other. Students will build a fault block model and simulate the different types of motion across a fault. They will compare and contrast the results of different types of fault motion.

**Lesson Outcomes:**

The students will:

- Assemble Earth's plates into a current world map
- Model the interaction between plates at different types of boundaries
- Learn that the interaction between these plates is what causes earthquakes
- Simulate the motion across the three different types of earthquake faults
- Compare and contrast the outcomes of different types of fault motion

## **Activities:**

### MilkyWay Tectonics

#### Materials:

Mini Milky Way bars for each student

One larger Milky Way bar for the teacher (easier for the students to see)

Napkins

#### Background:

Students should already have been introduced to the names of the different types of plate boundaries. An in depth background isn't necessary, but they should have heard of the different types of boundaries and seen a map with Earth's plates and the plate boundaries.

#### Activity:

- Give each student a wrapped mini-Milky Way
- Explain that they are going to be modeling the different ways plates interact with each other
- Tell the students that they will be able to eat the Milky Way at the end of the lesson, but first they need to follow the directions
- Divergent Plate Boundaries: Plates that share a divergent boundary are pulling away from each other. Using the larger candy bar, the teacher should model pulling the Milky Way apart. Don't pull so that the candy bar splits into two, only pull so that the chocolate breaks and you can see the caramel and nougat inside the bar. Emphasize to the students that they aren't breaking the candy bar into two pieces. Have students take out their Milky Way and gently pull apart. The chocolate is like the brittle lithosphere. Students can see that the chocolate breaks. This breaking is where the plate boundary forms and where most of the earthquakes occur. Underneath the broken chocolate the students should be able to see the caramel stretching and getting thinner (the material that will be used to form new crust, replacing the older crust that just moved away). This shows that there isn't empty space left behind when the plates pull away from each other. It also shows that there is thinning of the earth where plates are moving away from each other. When done with this boundary, have the students push the Milky Way back together so that it looks as close as possible to what it looked like when they first took it out of the package.
- Convergent Plate Boundaries: Plates that share a convergent boundary are being pushed towards each other. Again, using the larger candy bar, the teacher should model pushing the two "plates" of the candy bar together (use the boundary already created by the diverging plates – this is a good example for the students to see that the boundary forms in the region of weaker crust). Two possible outcomes will occur. Either the broken chocolate will push up against each other and form "mountains", or one piece of chocolate will get pushed underneath the other. These are both examples of what happens when two plates come together. The mountains will form when two continental plates collide, and subduction (one plate going underneath the other) will happen when one (or both) of the plates are

made of oceanic crust and it goes underneath the other plate. The good thing about having a whole class of students do this is that some of the class will get mountain building while others will get subduction. After showing how to make the collision, allow the students to model a convergent boundary with their Milky Ways. When done with this boundary, have the students move the Milky Way back to its original state (or as close as possible).

- **Transform Plate Boundaries:** Plates that share a transform boundary are sliding past each other. Using the larger candy bar, the teacher should model sliding the two “plates” of the candy bar past each other. There should be minimal deformation of the candy bar at this point, no new material should be visible, and no new material was formed. The “plates” can move either to the right or left of each other, as both types of boundaries exist. Allow students to model transform plate boundaries with their Milky Ways.
- Enjoy the Milky Ways, yum!

## Plate Puzzle

### Materials:

Puzzle Pieces (one set per student) [master copy included, 2 pages]

Answer Key [master copy included, 1 page]

Scissors

Colored pencils or crayons

Glue or tape

Piece of Construction Paper (1 per student)

Soccer ball

World Map

Internet Access

### Background:

None needed.

### Activity:

- Explain to the students that just like a puzzle, the earth is made out of pieces. Hold up the soccer ball and show to the class. Just like the soccer ball is made out of different sized and shaped pieces, so is the earth. The only difference is that Earth's pieces are not regularly sized or shaped like the pentagons and hexagons of a soccer ball.
- Hand out materials to students. Hold up the two sheets with the plate pieces on them. Tell the students that these are the pieces that make up the earth. The pieces are called plates (the larger pieces have their names written on them). The gray parts of the pieces are land and the white parts are ocean.
- Give the students a minute to look at the different pieces. Ask the students if they can find a plate piece that is mostly ocean and has hardly any land on it. (Pacific Plate, Nazca Plate, Cocos Plate, Antarctic Plate, Philippine Plate, Caribbean Plate) What about plate pieces that are mostly land. (Arabian Plate, Indian Plate, Eurasian Plate) Which plates have a combination of land and ocean? (African Plate, South American Plate, North American Plate, Australian Plate) Have the students look at the pieces and ask if the edges of the pieces match with the edge of the continents. (They don't)
- Explain to the students that they are going to cut out the pieces and assemble them to make a map of the way the earth looks today. First they are going to color in each plate a different color. Two things to note: 1) point out that the plates include both continent and ocean and that they should be colored as one; 2) even though the Eurasian Plate appears to be two pieces it is really just one. It is split only because the map is a flat representation of a round earth. Both pieces should be colored in the same color.
- Color before cutting!
- After the students have colored and cut out the plate pieces have them place the pieces onto the construction paper arranged as the world looks today. Have a copy of a world map for the students to refer to as a guide (just like the picture on

a puzzle box helps make assembling the puzzle easier, so will having a world map to look at).

- Students then glue the pieces to the construction paper.
- Have students compare their assembled plate map with map of earthquakes around the world. The map can be found at:  
[http://atlas.geo.cornell.edu/education/instructor/earthquakes/images/world\\_seis.gif](http://atlas.geo.cornell.edu/education/instructor/earthquakes/images/world_seis.gif) (a black and white version can be found at:  
[http://solid\\_earth.ou.edu/notes/seismicity/global/shallow\\_eq\\_map.gif](http://solid_earth.ou.edu/notes/seismicity/global/shallow_eq_map.gif)) Help your students draw conclusions about the correlation between plate boundaries and earthquake locations. (Earthquakes are caused by movement along plate boundaries). To help the students recognize this correlation ask them to remember the Milky Way activity and that the plates move and interact at the boundaries.

## Fault Block Models

### Materials:

Scissors

Crayons or pencil

Fault Block Paper (one per student) [master copy included, 1 page]

Tape

Blank piece of paper (one page for the older students)

### Background:

No background necessary, but should do plate boundary lessons first.

### Activity:

- The teacher should make an example of the model before the students do so that they can see what they are working towards.
- Explain to students that the different types of plate boundaries cause different types of earthquakes to happen. Today they are going to make a model where they can demonstrate the difference between these earthquake types. Show the students your model so they know what they are going to build.
- Have students color in the fault block paper. Layer one should be colored in brown, layer two should be colored in yellow and layer three should be colored in orange. The top should have a blue river, a black road and green for the grass.
- Students should then cut out the blocks along the bold black lines along the edges.
- Students should then fold along the remaining bold black edges and tape the sides together to make a three-dimensional model.
- For the younger students, the cutting and taping should ideally be done in small groups, with a parent volunteer if possible.
- Lead the students in modeling the different types of earthquakes: normal, reverse and strike-slip. For example: have the students match up the two Ns to show what the earth looks like after a normal earthquake; have the students match up the two Rs to show what the earth looks like after a reverse earthquake; have the students match up the two LLs to show what the earth looks like after a left-lateral strike-slip fault; have the students match up the RLs to show what the earth looks like after a right-lateral strike-slip fault. For the older students you can give them blank pieces of paper and have them draw what they see after modeling each earthquake
- Call out the different types of earthquake faults and have the student demonstrate them using their models.