Plate Tectonics and Their Impact on Earth’s Structure

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Mountains, Earthquakes, Volcanos, oh my! This unit plan covers topics that revolve around Earth’s plates - where the plates are, how they move, and what happens at those boundaries. These lessons are grounded in hands-on activities and research projects that allow students to wrap their minds around the idea that the Earth is always shifting, even if they have never realized it before.

Created from Wisconsin’s Next Generation Science Standards, Fourth Grade

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***Lesson 1, Earth’s Plates***

**Standards Addressed** (Common Core State Standards/Local Standards)

* 4-E.SS2.B
* 4-ESS2-2
* RI.4.7
* W.4.8
* MP.2
* B.4.1

**Vocabulary for the lesson**:

Earth’s plates: the layers of rock that cover the Earth’s surface and layers of the Earth.

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| **Objective** | **Assessment** |
| The students will review the Earth’s layers. | Class modeling of the layers with teacher. |
| The students will understand that the Earth is made up of plates. | Play-doh and styrofoam ball activity |

**Instructional Strategies and Learning Tasks (Procedures & Timelines)**

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| **Time** | **Instructional Strategies/Learning Tasks** | **Purpose** |
| 5 min. | Review layers of the earth, have students model the layers with hands as teacher instructs. We will talk about the different layers:  -inner core  -outer core  -mantle  -crust  The teacher will use their hands to show the layering of these materials. | Students will have a vantage point for the rest of the lesson when we refer to the crust and mantle. |
| 5 min. | We will discuss the definition of plates and the role plates play in our Earth’s systems.  A plate is a large layer of rock that covers the Earth’s surface over the layers of the Earth.  What do you think they do for our Earth? | This is an introduction into what plates are and how they are structured in the earth. |
| 5 min. | As a group, students will have an interactive look at plates on our Earth on the website <https://ees.as.uky.edu/sites/default/files/elearning/module04swf.swf>. We will also discuss the idea that we use smaller models of the plates because they are too big to observe in real-life. | This gives students a visual for the location of the plates and their boundaries. |
| 5 min. | We will introduce a globe model of plates and discuss how the plates seem flat on the computer and in the text, but are really the shaping points of our Earth. | Students will see that the model on the computer is flat, but it is showing the earth. Seeing the globe, they can connect that the model on the computer, if real, would be round. |
| 15 min. | Students will be given a styrofoam ball and Playdoh to start. We will also give them a [handout](https://docs.google.com/document/d/1UFx3CLzS1hVEzMjv-s6o_3xbiA04pCSZkxdLQbEUzYI/edit) with the plate outlines on them. The students will shape the Playdoh in the shape of the “plates” and have to place them correctly on the styrofoam ball or the “Earth”. We will give them an example for reference.  Materials needed:  Styrofoam Ball  Play-doh  Reference sheet | This is a visual and physical representation of the plates that the students can see and refer to. |

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***Lesson 2, Plate Boundaries***

**Standards Addressed** (Common Core State Standards/Local Standards)

* 4.E.SS2.B
* 4-ESS2-2
* RI.4.7
* W.4.8

**Vocabulary for the lesson**:

Plate boundaries: the location at which two plates come together and touch each other, so they are adjacent

Transform boundaries: when two plates rub up against each other or slide past each other

Convergent boundaries: when two plates come together

Divergent boundaries: when two plates move apart

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| **Objective** | **Assessment** |
| The students will review what the Earth’s plates are. | We will have a discussion and ask students questions relating to what we previously learned. |
| The students will understand what a plate boundary is. | [Exit slip](https://docs.google.com/document/d/1rqzVJZwDKwCOZvcHZ-OGC2OXIYrNmg7B3T7QdrGdSzQ/edit): we will include questions on plates and plate boundaries, not including the types. |
| The students will understand the different kinds of plate boundaries: transform, divergent and convergent and their different processes. | Students will give examples of ways they can demonstrate the three kinds of plate movements (ex. moving their feet together, apart, and against each other; graham crackers) |

**Instructional Strategies and Learning Tasks (Procedures & Timelines)**

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| **Time** | **Instructional Strategies/Learning Tasks** | **Purpose** |
| 5 min. | Review definition of plates and their impact on Earth.  Do you remember what the Earth’s plates are?  Can you name one or two?  What do they do? | This gets the students in the mindset of plates and gets them thinking about what they learned the day before. |
| 5 min. | We will discuss the definition of plate boundaries in relation to plates. We will use graham crackers to show a very basic form of plate boundaries.  A plate boundary is the location at which two plates touch or are adjacent to one another. | This gives students a visual concept of plate movement. This will help students understand that the plates are too big to show in a real-life scale model and we must show it in scale they can comprehend. |
| 10 min. | Using the graham crackers as an example, we will discuss the three main types of plate boundaries: transform, convergent and divergent.  Transform boundaries: are when two plates slide past each other  Convergent boundaries: are when two plates come together  Divergent boundaries: are when two plates move apart | This give students a visual for the different types of plate movement so they know the differences and specifics of each. This smaller-scale will allow students to again realize that we are unable to use real-life scale models to show the movement of the plates. |
| 5 min. | The students will participate in an interactive website that will refine their knowledge of the different types of plate boundaries and give them a real-world example of plate boundaries. <http://www.learner.org/interactives/dynamicearth/plate.html>  We will also discuss the idea that the plate boundaries are also too big to observe, so we must bring it down to size, that is why we use the website and graham crackers for reference. | This gives students an interactive and personal discovery opportunity to learn more about the plate boundaries. Using this website, they are able to refine their knowledge of the information we gave them in their own ways and be able to express the new information in their own ways. |
| 15 min. | Students will use body movements to portray their knowledge of the different plate boundaries, or they are able to use real-world applications to portray their understanding of boundaries. | The allows students to take what they’ve learned and apply it in an interactive and kinesthetic way for our assessment and their refinement. This can also help students understand the information in new ways as their peers discuss plate tectonics in their own ways. |
| 2 min | We will pass out a [worksheet](https://docs.google.com/document/d/10kocrS6DFa1cN7CFJfOdMNBty03TFgogXfo6VapQ-ow/edit) with visual representations of transform, convergent and divergent boundaries. | This will be a review for students in this and subsequent lessons. |
| 5 min | We will pass out an exit slip for review. | This gives the students a chance to write down some things they have learned and helps us to know what still needs some work. |

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***Lesson 3, Asthenosphere and Lithosphere***

**Standards Addressed** (Common Core State Standards/Local Standards)

* 4.E.SS2.B
* 4-ESS2-2

**Vocabulary for this lesson**:

Asthenosphere: the thicker layer of the earth, that is like melted plastic that moves and glides; made of upper mantle.

Lithosphere: the thinner layer of the earth, that is rigid that rides on the asthenosphere like a raft on a river; made up of upper mantle and crust.

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| **Objective** | **Assessment** |
| Students will understand the concepts of asthenosphere and lithosphere. | Game for asthenosphere and lithosphere identification. |
| Students will understand that the asthenosphere and lithosphere influence the plate boundary movement. | Oreo activity |

**Instructional Strategies and Learning Tasks (Procedures & Timelines)**

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| **Time** | **Instructional Strategies/Learning Tasks** | **Purpose** |
| 5 min | Review plate boundary movements.  What do transform boundaries do?  What do convergent boundaries do?  What do divergent boundaries do? | Get the students minds in gear for the lesson; help them retain the information from last class. |
| 7 min | We will begin by asking students how they think the plates move on the Earth’s surface. Off of their answers, we will introduce the asthenosphere and lithosphere, explaining that they are the key to plate movement. We will talk about how the asthenosphere, glides and move the lithosphere (or plates) around. | “Huh” factor; introduce the concepts. |
| 2 min | We will pass out a sheet of [guided notes](https://docs.google.com/document/d/1Nt4ldE7ZcL580l-hgzqQTpau7mNiB288X3IQGXqo1rM/edit), and students will fill it out as class goes on with notes about lithosphere and asthenosphere. | This will be a good anchor for students to refer to when playing the game and throughout subsequent lessons. |
| 4 min | We will use the model previously introduced in the first lesson to talk about the layers of the Earth, explaining to students that we will be added two new layers when we talk about asthenosphere and lithosphere. | Students will have a fresh memory of the layers of the Earth that we will add on to. |
| 10 min | We will discuss how the lithosphere rides on the asthenosphere like a raft on a river and how it influences plate movement. We will use a [Prezi](https://prezi.com/qkviajwlb47h/asthenoshpere-and-lithosphere/?utm_campaign=share&utm_medium=copy) as a visual and information source for the student’s guided notes. | This will be a good source of information for students and give them time to fill in guided notes for their memory and review. |
| 8 min | We will model the movement of the asthenosphere and lithosphere using Oreos as a model. We will also discuss that we are unable to use full-scale models of these layers because it is too big to model in a real-life setting. | We will be able to give students a visual representation of the movement of the lithosphere and asthenosphere for their memory. |
| 4 min | We will introduce the idea that when the plate boundaries move, natural occurrences form, like earthquakes, volcanoes and mountain ranges. This will be brief. | This will prepare students for the next lesson and allow them to have a head-start on new information. |
|  | Students will have two notecards on popsicle sticks of different colors. Each color will be identified as either asthenosphere or lithosphere. We will state a characteristic of asthenosphere and lithosphere, and the students will hold up the card with their answer.   * Asthenosphere   + like melted plastic   + thicker layer   + moves and glides   + upper mantle * Lithosphere   + rigid top layer   + rides on top of the other   + thinner   + crust + upper mantle | Formative assessment to gauge the understanding of this lesson’s material. |

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***Lesson 4, Earthquakes, Volcanoes, Mountain Ranges***

**Standards Addressed** (Common Core State Standards/Local Standards)

* 4.E.SS2.B
* 4-ESS2-2
* RI.4.7
* W.4.8
* W.4.7
* A.4.2

**Vocabulary for this lesson**:

Earthquake: a rumbling, shaking or sudden movement of the Earth’s ground

Volcanoes: mountain that opens downward to a pool of molten rock below the surface of the earth; when pressure builds up, eruptions occur

Mountain ranges: a series of mountains in a row

Mountain: landform that rises above the surrounding land

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| **Objective** | **Assessment** |
| Students will understand and define the three major natural occurrences: earthquakes, volcanoes, and mountain ranges. | Class discussion |
| Students will understand the instances in which these natural occurrences form. | [Exit slip](https://docs.google.com/document/d/14lMLTLLlU1sOy1B3YSMmvbh160AwV24vgDScBhvT7ew/edit)- we will also include information on asthenosphere, lithosphere and plate boundary types. |
| Students will conceptualize their knowledge of these natural occurrences to real-life examples. | Group research projects |

**Instructional Strategies and Learning Tasks (Procedures & Timelines)**

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| **Time** | **Instructional Strategies/Learning Tasks** | **Purpose** |
| 5 min | Review the asthensophere and lithosphere and their influence of boundary types [how the asthenosphere guides the lithosphere and all of the Earth’s plates to either a. glide past one another, b. come together or c. slide apart] by making an anchor chart. We will use the raft and the river as the ideas of the asthenosphere and lithosphere and illustrate the rafts coming together [convergent], spreading apart [divergent] and gliding past each other [transform], and talk about the river or the asthenosphere during all of these events.  Materials needed:  Blue paper (for the river)  Cut outs of rafts  Black marker (to show direction) | Get students in the mindset of the day’s lesson with a collaborative and unique review session, it will also provide students with a mental anchor for further lessons. |
| 5 min | We will give students definitions of earthquakes, volcanoes and mountain ranges. We make an anchor chart with students for each natural occurrence for their mental anchors:  An earthquake is a rumbling, shaking or sudden movement in the ground  A volcano is mountain that opens downward to a pool of molten rock below the surface of the earth; when pressure builds up, eruptions occur  A mountain range is a series of mountains in a row | The anchor charts and definitions ensure that students are all on the same page for the concepts we are using. |
| 8 min | We will discuss the instance in which earthquakes form, during transform boundaries and give examples through the website [http://earthquake.usgs.gov/earthquakes/map](http://earthquake.usgs.gov/earthquakes/map/#%7B%22feed%22%3A%221day_m25%22%2C%22search%22%3Anull%2C%22listFormat%22%3A%22default%22%2C%22sort%22%3A%22newest%22%2C%22basemap%22%3A%22grayscale%22%2C%22autoUpdate%22%3Atrue%2C%22restrictListToMap%22%3Atrue%2C%22timeZone%22%3A%22utc%22%2C%22mapposition%22%3A%5B%5B-86.85607435433805%2C-613.125%5D%2C%5B86.357579368499%2C61.17187499999999%5D%5D%2C%22overlays%22%3A%7B%22plates%22%3Atrue%7D%2C%22viewModes%22%3A%7B%22list%22%3Atrue%2C%22map%22%3Atrue%2C%22settings%22%3Afalse%2C%22help%22%3Afalse%7D%7D).  We will talk about how when the two plates rub up against each other, there is a lot of tension and pressure that leads to the quake. | This will give students an in depth look at earthquakes and make real-life connections from knowledge learned in the classroom to the actual world. |
| 8 min | We will discuss the instance in which volcanoes form, during divergent and convergent boundaries and give examples through the website <http://video.nationalgeographic.com/video/101-videos/volcanoes-101>  We will discuss that when two plate separate, the crevasse they form is filled with molten lava and eventually explodes.  We will also discuss that when two plates come together, one plate moves underneath the other, melting and rising lava spouts from the visible plate.  We will also discuss the different types of volcanoes: composite [volcano layered with eruptive material like cemented lava], cindercone [cone-shaped vent in a volcano] and shield [a flat volcano that looks like a shield, built of lava flows], but students will not be tested on these topics. | This will give students an in depth look at volcanoes and make real-life connections from knowledge learned in the classroom to the actual world. |
| 8 min | We will discuss how and where mountain ranges form, during convergent boundaries. We will allow them to explore different mountain ranges through the use of the website: <http://www.ducksters.com/geography/mountain_ranges.php> and the website: <http://science.nationalgeographic.com/science/earth/surface-of-the-earth/mountains-article/>  We will discuss that when two plates come together, they push rock together and upward, creating mountain peaks like those in the examples. | This will give students an in depth look at mountain ranges and make real-life connections from knowledge learned in the classroom to the actual world. |
| 10 min | We will explain our project for the students: they will be getting into groups of 3-4 and will be given either a natural disaster like volcano or earthquake or a natural occurrence like a mountain range to make a presentation on. We have given them plenty of [websites](https://docs.google.com/document/d/1pkwlfEjnNXsdktRt7lWf8cul4SV0ij-tnZcrbTOW1nU/edit) to look up information on the different natural occurrences and therefore they must look back at their resources to find information. They will need to make a 5 minute presentation about the natural occurrence. It will include the following:  -Type of natural occurrence  -Name  -Formation (type of boundaries, interesting features)  -Location  -Damage caused (depending on the natural feature given)  This will be done on computers/ powerpoint because they are done in class. If students want to use materials to make a poster, they are allowed. | To help students align and anchor their knowledge on these natural occurrences to a strict and specific assignment. This also helps them test their knowledge, collaboration skills and presentation abilities. |
| 25 min | Depending on the number of groups we use, the students will make a quick presentation and present to the class.  \*If the preparation took too long during our lesson and we are over time limits, we can move the presentations to the next day. | This tests their knowledge on the subject learned, also tying in other lessons with it, and allowing us to have a valid assessment of academic growth on the subject. |
| 5 min | After all presentations, we will give them an exit slip that covers the asthenosphere, lithosphere, plate boundary types and how they affect the Earth’s surface. | This helps students review for the final examination. |

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***Lesson 5, Earthquake Preparedness***

**Standards Addressed** (Common Core State Standards/Local Standards)

* 4.E.SS2.B
* 4-ESS2-2

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| **Objective** | **Assessment** |
| Students will understand how to be prepared when an earthquake strikes: the movements, what to avoid, communication and storage. | Discussion, answering questions |
| Students will show the teachers how to respond during an earthquake. | Mock earthquake |

**Instructional Strategies and Learning Tasks (Procedures & Timelines)**

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| **Time** | **Instructional Strategies/Learning Tasks** | **Purpose** |
| 5 min | We will ask students if they have ever been in an earthquake. | This gives students real-life applications of such natural occurrences and the lesson we are teaching. |
| 5 min | We will ask students what they think is appropriate procedures during an earthquake.  What should you do?  What shouldn’t you do?  Where should you go?  Where shouldn’t you go? | This gives students the “huh?” factor and allows them to use their knowledge to make predictions. |
| 8 min | We will discuss proper measurements to take when faced in an earthquake. This includes:  Dropping to your hands and knees, cover your head and neck with your arms, hold on to any sturdy shelter until the shaking stops. Stay away from glass, anything that could fall, windows, doors. DO NOT GET INTO A DOORWAY, STAY INSIDE ALWAYS. | This is vital information for the off-chance they experience an earthquake in their lives. It is also great critical thinking skills for students to use in other emergency experiences. |
| 8 min | We will also talk about the ways to communicate with family and how to store food, water and other supplies. We will talk about how to communicate to family members before the earthquake strikes, set up a central meeting point and always have a kit ready for that time that has adequate non-perishable food, water, first aid, flashlight, and other essentials. | This will deepen their understanding of the preparedness plan they will set up when they are at risk of an earthquake. |
| 10 min | We will do a mock earthquake for the students the next day: turn off the lights and instruct them to get into position. We will also go through a range of scenarios: when things fall off shelves, when windows break, etc. | This will test their knowledge of earthquake preparedness and allow us to assess students on their knowledge. |
| 5 min | We will pass out study guides and extra notes so students will be able to use to prepare for the final test. | This helps students anchor information and study for the final with some guidelines to ensure success. |
| 20 min | \*Could be used the following day  [Trashketball Review Game](https://docs.google.com/document/d/1rdIEKpweCMpozEy8IZ-LQZEYMdKn_kcyBlyFf4_LjIY/edit) | This game allows students a good and memorable review session so they are able to remember key facts and information for the unit test. |

\*After these five lessons, students will take a [final test](https://docs.google.com/document/d/1ugN1QNbPj4vG7lcVaNsTSZDT3VfBIBaFOkwvjSSE2p8/edit) that touches on the key information of these lessons. It will be decided at the time if students need to use their notes or if they are developmentally ready to work on their own. It will be adapted for a technology base where students use clickers to answer questions used on a website.

**References**

Interactive Plates Website:<https://ees.as.uky.edu/sites/default/files/elearning/module04swf.swf>

Graham Cracker Activity: <http://www.windows2universe.org/teacher_resources/teach_snacktectonics.html>

Oreo Activity: <http://training.oldcolonycouncil.org/docs/oreo_cookie_plate_tectonics.pdf>

Earthquake Information: [http://earthquake.usgs.gov/earthquakes/map](http://earthquake.usgs.gov/earthquakes/map/#%7B%22feed%22%3A%221day_m25%22%2C%22search%22%3Anull%2C%22listFormat%22%3A%22default%22%2C%22sort%22%3A%22newest%22%2C%22basemap%22%3A%22grayscale%22%2C%22autoUpdate%22%3Atrue%2C%22restrictListToMap%22%3Atrue%2C%22timeZone%22%3A%22utc%22%2C%22mapposition%22%3A%5B%5B-86.85607435433805%2C-613.125%5D%2C%5B86.357579368499%2C61.17187499999999%5D%5D%2C%22overlays%22%3A%7B%22plates%22%3Atrue%7D%2C%22viewModes%22%3A%7B%22list%22%3Atrue%2C%22map%22%3Atrue%2C%22settings%22%3Afalse%2C%22help%22%3Afalse%7D%7D).

Volcano Information: <http://video.nationalgeographic.com/video/101-videos/volcanoes-101>

Mountain Range Information: <http://www.ducksters.com/geography/mountain_ranges.php> ;

<http://science.nationalgeographic.com/science/earth/surface-of-the-earth/mountains-article/>

Earthquake, Volcano and Mountain Range Project Websites: <https://docs.google.com/document/d/1pkwlfEjnNXsdktRt7lWf8cul4SV0ij-tnZcrbTOW1nU/edit>

Earthquake Safety: <http://www.ready.gov/kids/know-the-facts/earthquakes>

Trashketball Review Game Structure: <http://www.loveteachblog.com/2014/02/five-ways-to-spice-up-your-teaching.html>

Notes and Information: Geology Class Notes, Dr. Tim Flood