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I. Lesson 1: Modeling the Earth--Motion Mock-Ups

What are earthquakes and what causes them?

Lesson Description: During this lesson students will perform a research jigsaw activity. The purpose of this activity is to get students to teach each other about: the mechanics of plate tectonics, faults and plate boundaries, how fault slippage causes earthquakes and how seismic waves travel. Students will read about and model one of these topics. They will then present their findings to the class.

Grade Levels: 4-12

Education Outcomes:

Students will restate and explain:

- The properties of tectonic plates and how they move.
- Faults and the difference between the various types of fault boundaries.
- How fault slippage releases energy waves that cause the earth to move.
- The differences between surface and body waves
- How the differences in wave travel determines how we experience earthquakes.

Education Standards

Met: (Note: bolded parts of the standards are fully met by this lesson)

Common Core Standards:
(4-12) CCSS.ELA-Literacy.SL.4.4, 5.4. 6.4, 7.4, 8.4, 9-10.4, 11-12.4:
Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

NGSS Cross-Cutting Concepts:
Systems and System Models: Defining a system under study-specifying its boundaries and making an explicit model of that system provides tools for understanding and testing ideas that are applicable throughout science and engineering.

NGSS Science and Engineering Practices (SEP):
Developing and using models: Makes use of models and simulations to analyze systems to identify flaws that might occur or to test possible solutions to a new problem.

Obtaining, Evaluation and Communicating Information: Ideas and findings are communicated clearly and persuasively. Students learn about the findings of others.

Addressed: (The following standards are practiced in this lesson but are not explicitly taught and assessed)
Next Generation Science Standards (NGSS)
4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycle of matter by thermal convection.

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II. Advanced Prep & Set-Up for Lesson

Set-Up for Reading Activity and Discussion

Materials

- Copies of the readings (At least one reading per topic group. Each student will need one copy of their assigned reading). Suggested online and book resources are listed below.
- Paper/ whiteboard for class KWL chart
- Pencils (in case students want to take notes).

Suggested Web Resources Organized by Jigsaw Group

Facilitator Note:
The following online resources that are accessible, and easy to print out. See Appendix B for additional online resources.

Layers of the earth: How is the earth structured? What are the different rock layers of the earth?

Grade Level	Website URL	Site description
4th - 6th	http://www.education.com/science-fair/article/earth-layers-chemical-physical-properties/	Gives an overview of the layers of the earth. Not very specific but useful for elementary grade levels.
Middle School	http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Inside.shtml	Describes the different layers of the earth.
High School	http://education-portal.com/academy/lesson/composition-of-earths-internal-layers-crust-mantle-and-core.html#lesson	Gives a detailed description of the different parts of the earth.

Plate Tectonics: What are tectonic plates and what causes them to move?

Grade Level	Website URL	Site description
4th – 6th	http://scienceforkids.kidipede.com/geology/platetectonics/	Basic explanation of plate tectonics and how it works.
Middle School	http://csep10.phys.utk.edu/astr161/lect/earth/tectonics.html	Gives overview of plate composition and how plates move. Explains the importance of plate tectonics and its significant to earth shape and formation.
High School	http://education.nationalgeographic.com/education/media/plate-tectonics/?ar_a=1 AND http://www.platetectonics.com/book/page_4.asp	Describes plate tectonics and how they move via convection.

Epicenters, Earthquake Focus and Seismic Waves: How do waves travel and how do they influence our experience of earthquakes?

Grade Level	Website URL	Site description
4th - 6th	http://www.geography4kids.com/files/earth_earthquake.html	Explains fault slippage, what an earthquake is and how waves travel.
Middle School	http://allshookup.org/quakes/wavetype.htm	Describes the different types of earthquake waves.

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High School	http://www.geo.mtu.edu/UPSeis/waves.html	Specific and detailed descriptions of different types of seismic waves.

Faults and Boundaries: Where do earthquakes occur? What are the different types of faults and boundaries and how do these affect earthquakes?

Grade Level	Website URL	Site description
4th - 6th	http://www.ducksters.com/science/earth_science/plate_tectonics.php AND http://www.nature.nps.gov/geology/usgsnps/deform/gfaults.html	Gives an overview of plate tectonics and how it works. Describes the different types of boundaries. The second source gives diagrams and describes different types of fault lines.
Middle School	http://science.howstuffworks.com/nature/natural-disasters/earthquake2.htm AND http://www.platetectonics.com/book/page_5.asp	Teaches about faults, plate boundaries and their relation to earthquakes. The second source talks about the different types of boundaries and where they typically exist.
High School	http://education-portal.com/academy/lesson/plate-boundaries-convergent-divergent-and-transform-boundaries.html#lesson	Basic overview of convection and how it causes the movement of tectonic plates. Talks about how this creates convergent and divergent boundaries.

San Jose Public Library Book Suggestions (Optional)

Grades 4-6

Book Title	Authors	Description
Geology Crafts for Kids: 50 Nifty Projects to Explore the Marvels of Planet Earth	Alan Anderson, Gwen Diehn, Terry Krautwurst	General earth science activities explore subjects such as volcanoes, fossils, rocks & minerals, and erosion.
Earthquakes and Other Natural Disasters	*Harriet Griffey*	Tells of the science behind natural disasters.
Rocks and Minerals (Eyewitness Books),	*R. F. Symes, Colin Keates*	Full color pictures and interesting text about the formation and uses of rocks and minerals.
Volcano and Earthquake (Eyewitness Books number 38),	*Susanna Van Rose, James Stevenson*	Book discusses where and how earthquakes and volcanoes occur, prediction, and human interaction with these natural phenomena.
Earthquakes, volcanoes, and tsunamis : projects and principles for beginning geologists	*Matthys Levy and Mario Salvadori*	This in-depth resource will teach readers how to build a seismograph to record a simulated earthquake, compare pressure waves and shear waves, and discuss issues of modern architecture and civil engineering
The Science of Earthquakes	*Matt Anniss*	Introduces earthquakes, discussing what causes them, the destruction they cause, how scientists study them, and how to stay safe if an earthquake hits.
Earthquakes	*Graeme Davis*	Shows how math skills can be used to learn more about earthquakes, including the triggers, the destruction left behind, and where they occur most often.
Earthquake Alert	*Shilpa Mehta-Jones*	Introduces earthquakes, discusses seismic waves, and explains how to stay safe.
Plate Tectonics	*Greg Young*	A great introduction to plate tectonics. Explains basic processes behind plate tectonics.

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How the Earthworks	*John Farndon*	Has detail diagrams and illustration showing the layers of earth. Also explains and illustrates how plate tectonics work.
Incredible Earth	*Nick Clifford*	Great introductory book to layers of the earth, plate tectonics and plate boundaries.

Middle/High School

Book Title	Authors	Description
Earthquakes and Volcanoes	*Ellen Prager*	Describes how plate tectonics and shifts in the Earth's crust cause earthquakes and volcanoes, and explains the danger behind the events and how the risks involving them can be reduced.
Predicting Earthquakes	*John Farndon*	Discusses the reasons why earthquakes occur, the effects of an earthquake, how they can be predicted, and ways to prepare for an earthquake
Earthquakes : the science behind seismic shocks and tsunamis	*Alvin Silverstein, Virginia Silverstein, and Laura Silverstein Nunn*	Examines the science behind earthquakes and tsunamis, including what makes them happen, where they occur, how they are measured, and tips to stay safe during an earthquake

Modeling Set-Up

Materials

NOTE: The following materials are suggestions of the types of materials needed for this lesson. Feel free to modify the following list to easily accessible materials. In general, you will need:

- Materials for building and sculpting
- Materials for sketching and designing
- Optional: Computers with animation/3D sketch/video creation program (i.e. Sketch-up, educreations, iMovie, etc.)

Sample Materials:

- Paper (Legal size and poster size – at least one sheet per group)
- Colored pencils (a variety of colors for each group)
- Crayons (a variety of colors for each group)
- Markers (a variety of colors for each group)
- Pencils
- Modeling clay (a variety of colors – enough for each group)
- Pipe cleaners (10 per group)
- Adhesives (tape, glue etc.)
- Tin foil (one 12 in x 12 in square per group)
- Popsicle sticks (at least 10 per group)
- Drinking straws (at least 5 per group)
- Hot plate
- Glassware (12 – 16 oz.)
- Tap water (1 liter)
- Food coloring
- Slinkys
- Rope
- String
- Coffee Stirrers (at least 5 per group)
- Substances and materials that can serve as good representations for Earth's layers. (Food items such as bread, condiments, etc.)

Facilitator Note:
Students may think of other materials they would like to bring in or use in their models. To allow for this creative thinking, you might have a general policy that they can use other "teacher-approved" materials. As the instructor, check that students can justify why the material is a good representation for what they are modeling.

Model Resource Station Set-up

- Set-up resources so that students have access to them during their model creation session.
- This set-up can be a single station or multiple stations depending on the set-up of the classroom and the number of students in the class.

III. Modeling the Earth Lesson Guide

Guiding Question: What are earthquakes and what causes them?

A. Lesson Introduction (20 – 25 minutes)

1. Introduce the design challenge theme. Some of the information you might share in this introduction could include:
   - The city of San Jose has asked us to help design and build an earthquake-resistant skyscraper.
   - The purpose of constructing this building is to convince a large tech company to move its headquarters to San Jose. This means that the building must look nice, be safe, and hold the employees and equipment of this company.
   - This building must be able to withstand a powerful earthquake.
   - This project will also help us prepare for the culminating Tech Challenge.
   - To prepare for this challenge, we are going to conduct research.

2. Create a class KWL Chart.
   - On the whiteboard/chalkboard/piece of large construction paper construct a KWL chart. This chart guides *students to identify what they think they* ***K****now, what they* ***W****ant to learn and what they have* ***L****earned*. You will focus on filling out the first two columns of this chart during this portion of the lesson. A sample chart is listed below:

What do you think you **k**now about earthquakes **(K)**	What you **w**ant to learn **(W)**	What you have **l**earned **(L)**

   - Ask the students what they **know** about **earthquakes**. Write student responses in the **"K"** column (the first column) of the chart.
   - If the students are having trouble coming up with earthquake facts, you could ask:
     - Who has experienced an earthquake? What did you notice about how things moved?
     - What do you think causes an earthquake?
     - Are all earthquakes the same? How might they differ? What might cause these differences?
     - Are there vocabulary words you've heard used when talking about earthquakes? Which ones? What do they mean?
   - Ask the students what they **want** to learn about earthquakes. Write their responses in the **"W"** column (the second column) of the chart. If students are having a hard time answering questions, ask the questions below:
     - What do you want to learn about earthquakes?
     - What kinds of questions will help us to understand the cause of earthquakes?
     - What kinds of questions will we need answered in order to design buildings that can withstand an earthquake?
     - What do you want to learn about how **tectonic plates** move?
   - Group questions into topics for jigsaw groups. Suggested reading sources are based on the following suggested group topics; however, student questions might lead to additional or different topics:
     - ***Layers of the earth:*** **How** is the earth structured? What are the layers of the earth? Which layers are involved in earthquakes? How?
     - ***Plate Tectonics***: **What** are tectonic plates and what causes them to move?
     - ***Faults and Boundaries***: **Where** do earthquakes occur? What are the different types of faults and boundaries and how do these affect earthquakes?
     - ***Epicenters, Earthquake Focus and Seismic Waves***: **How** do earthquakes cause the ground to shake? What are seismic waves? How do seismic waves travel and how do they influence our experience of earthquakes?

Facilitator Note:
Please note that the "What you have learned" column of the table will be filled out at the end of the lesson.

We phrase this as "*What you think you know*" so that we can accept all knowledge, but come back and check our thinking after research.

Some possible answers for the *"What you think you know"* questions could include: the definition of a fault line or other vocabulary, an explanation of fault slippage or plate tectonics or how earthquakes can be different depending on where they occur (ocean, land, types of plate boundaries etc.).

Accept all answers in the initial brainstorm. After the brainstorm, if there are student-provided facts that you believe might be inaccurate, highlight or label them as facts that students may want to double check in their research.

Some possible questions for the *"What do you* ***w****ant to learn"* column could include: What causes earthquakes? What is a plate boundary? Are all earthquakes the same? How do earthquakes affect buildings?

3. Introduce the research activity. Some information you might share includes:
   - Students will conduct a research activity where they are going to try to answer their questions written in the *"What you* ***w****ant to learn"* column.
   - The class will fill out the final column of the chart at the end of the class.
   - Because earthquakes are complex, each group will research and model a different topic that they will teach back to the rest of the class.

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- The information students research and teach will be important to helping us to design earthquake-safe buildings.

4. Discuss the importance of modeling with students. Some of the talking points and questions you might include in this discussion are:
   - What is scientific modeling?
   - Scientific modeling is a generation of a physical, conceptual, or mathematical representation of a real phenomenon that is difficult to observe directly. An example would be creating a small model that shows how tectonic plates move. A model would make it easier to observe this process because tectonic plates are typically very large and move so slowly that their movement is usually difficult to observe.
     - A phenomenon is a fact or situation that is observed to exist, especially one whose cause or explanation is in question. (Examples of natural phenomena might include: hurricanes, tornadoes, volcanoes, decomposition, erosion, etc.)
   - Can you think of examples of models you have seen?
   - Examples might include weather or climate change predictions, scale models of the Earth (a globe) or solar system, how the earth may have looked in the past or might look in the future (continental drift, Pangaea), the formation of planets or galaxies.
   - Why do we have models like these? How do they help us?
   - Modeling is a good way to learn, understand and illustrate complex concepts particularly on a large scale or that occurs so slowly that we couldn't directly observe them.
   - Scientists use modeling to illustrate and to gain deeper understanding of scientific and engineering principles.
   - Scientists also use models to predict how scientific phenomena might behave in the future (e.g. weather, climate change, future continent locations), before humans (e.g. planet formation, Pangaea) or how phenomena might behave under different conditions.

5. Place students in their jigsaw groups based on the topics identified in the *"What do we **w**ant to learn"* section of the KWL.
   - These groups can be made at the discretion of the instructor. It is recommended that groups are no larger than 4.

B. Student Research and Model Development (50 – 60 minutes)

1. Introduce the research and modeling project. The following are suggested questions and talking points:
   - Students will research their topics so they can create and present a model to the rest of the class.
   - They will read articles/books and then draw and/or build a model with their groups.
   - They will have 3-5 minutes to present their models and research.

2. Assign each group vocabulary to research, define and present with their model. See suggested vocabulary listed below. It might be helpful to write this vocabulary on the board so that students can reference it while they research and prepare their presentations later.
   - Layers of the earth
     - Crust
     - Mantle
     - Lithosphere
   - Plate tectonics
     - Tectonic Plate
     - Convection
   - Faults and Boundaries
     - Fault
     - Transform Boundary
     - Subduction Boundary
     - Divergent Boundary
   - Epicenter, Earthquake Focus and Seismic Waves
     - Primary Wave
     - Secondary Wave
     - Surface Wave

Facilitator Note:
Facilitators are encouraged to have students look for examples of models on the internet. If they replicate an existing model, they should be prepared to justify why they selected that model as a good model.

For the *layers of the earth* group, students might create a physical model of the different earth layers—particularly the crust and mantle. Guide them to build this to scale and also to think about materials that are good analogs for each layer. (The crust is thin and brittle and floats on the viscous mantle.) For the *plate tectonics* group, students might create a moving model of tectonic plate movement. The might even model convection using a lava lamp or a hot plate, water and food coloring. For the *faults and boundaries* groups, students might model different types of faults. Finally for the *seismic waves* group, students might use rope, string or Slinkies to model wave movement.

See Appendix B for other examples of models.

3. Provide time for students to conduct their research. This may look different for different age groups. Some suggested methods might include:
   - Have students read a provided article aloud in pairs or small groups, taking turns reading and discussing what they are learning relevant to their group's question.
   - Have groups divide up different articles/books to read individually or in pairs. Encourage them to take notes on their group's topic/questions, as they read.
   - Give students 15 minutes to read an article assigned to their team in silence.

4. Discuss and share lessons learned as a whole group.
   - Write the guiding questions on the board:
     - How is the earth structured? What are the layers of the earth? Which layers are involved in earthquakes? How?
     - What are tectonic plates and what causes them to move?
     - Where do earthquakes occur? What are the different types of faults and boundaries and how do these affect earthquakes?
     - How do earthquakes cause the ground to shake? What are seismic waves? How do seismic waves travel and how do they influence our experience of earthquakes?
   - Give students 3 minutes to discuss the guiding questions. Students should only discuss the answers to the question that relates to their article. Students must agree on their answer to each question using evidence from their reading to support their responses. During this time walk around the classroom and check for understanding.

Facilitator Note:
While students are discussing the answers to their questions listen for strong answers that you can share with the group later. Make sure to listen for and correct any misconceptions or incorrect answers.

For earth's structure questions, listen for accurate descriptions of the characteristics of the crust, mantle and core and how they interact. For the tectonic plates question listen for accurate descriptions of a plate and how plates move due to convection. For earthquake questions, listen for accurate descriptions of the types of boundaries and how energy released causes an earthquake. Finally, for the waves question, listen for accurate descriptions of Primary, Secondary and Surface waves and how all there waves cause the ground to shake.

See Appendix A for definitions of vocabulary words referenced above.

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5. Introduce the modeling activity guidelines.

   Challenge:

   Students will design and create a model that illustrates their assigned topic.

   Criteria (Design Requirements):

   - Your team's model must accurately demonstrate your assigned phenomenon in a way that helps the rest of the class to understand that phenomenon quickly
   - Earthquakes are about motion, so all models should accurately demonstrate motion and causes of this motion.
   - Your model can either be a physical model (sculpture), an animation or a drawing.
   - ***Suggested bonus activity:*** Models that move will be awarded bonus points.
   - Your model must be large enough for the whole class to see from the front of the class.

   Constraints (Design Limitations):

   - Schedule: You have 30 minutes *(suggested)* to construct the model
   - All team members must help build the model and must present
   - You may only use materials available on the resource table or those approved by the instructor.

> **Facilitator Note:**
> Encourage students to be creative and to do their presentations in the form of a skit, news presentation, TV show etc. You can also provide a technology option for this segment of the lesson. Students can use basic animation generators like *Sketch Up* to create their models.
>
> The time allotted may be adjusted based on student needs/time available. We recommend a minimum of 30 minutes

C. Presenting the models (40 - 50 minutes)

1. Introduce the presentation guidelines.

   Challenge:

   Create, practice and present an earthquake model.

   Criteria (Design Requirements):

   - The presentation must be 3-5 minutes long.
   - The assigned phenomenon must be demonstrated and explained.
   - Students must speak clearly and at an understandable pace.
   - The group should also explain how your model is the same as the actual phenomenon and how it is different (strengths and limitations of the model).
   - Each group must define and discuss the key vocabulary for their topic. (See key vocabulary listed in Section B.2).
   - Everyone in the group must present.

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2. Have students present their models.
   - Before students begin presenting, go over audience norms.
   - Have students present. To manage time, you may want to assign a time keeper to hold up "1-minute" warning and "Times Up" signs.
   - While groups are presenting, have audience members record one positive thing they thought about each group's presentation and one thing that they learned from the presentation. Tell students that you are going to call on students randomly to share their "Wow" and their learned fact.
   - After each presentation call on at least three students to share their "Wow" and one thing that they learned from the presentation.

> **Facilitator Note:**
> Some suggested audience norms are: One person speaking at a time, no questions until the end of the presentation, no side conversations, be supportive etc.
>
> It is important to remind students that some people have harder times presenting than others. Encourage them to be supportive and caring when listening to their peers.
>
> It might be helpful to write the key vocabulary words on the board so students can refer to them while they prepare the presentations.

3. Debrief with the class. Some suggested questions and talking points might include:
   - What did you like about the presentations? Why?
   - Was it hard to present in front of the class? Why?
   - What do you think you did well today? Why?
   - What could you have added to your explanation/summary? Why?
   - What would be something you could do to improve your presentation? (Students participating in The Tech Challenge culminating competition, will need to present to judges, so this is good practice, for being prepared and presenting confidently and clearly).

4. Complete the "KWL chart from the beginning of the lesson.
   - Start to debrief using the following discussion points:
     - How is the earth structured?
     - What causes an earthquake?
     - Where do earthquakes start?
     - Why are we able to feel and experience earthquakes?
   - Fill out the "*What we have Learned"* section (the 3rd column) of the chart. Some questions that can guide this discussion include:
     - What were some things you learned during today's class?
     - What did you learn about plate tectonics?
     - What did you learn about earthquakes?
     - How will you use what you learned to design an earthquake-resistant skyscraper?
     - What did you learn about scientific models and how they are used?
   - Re-visit the "*What we think we know*" section of the chart to double-check accuracy of any facts listed.

> **Facilitator Note:**
> Students should walk away from the lesson with an understanding on how the earth is structured, plate tectonics and the relationship between plate movement and earthquakes. More specifically students should know that plate movement in the lithosphere cause energy release that in turn causes the earth to shake (an earthquake).

5. For the final activity of the lesson, challenge the class to work together and find a way to model how all 4 topic areas connect together using only themselves and the models created for the presentations.
   - If you have multiple groups for each topic, separate the class into groups that have representatives from all 4 topic areas.

IV. Appendices

A. Vocabulary and Background Information

Aftershock – Smaller earthquakes that come after larger earthquakes.

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Body wave – Seismic waves that only travel below the surface of the Earth. They can be classified as Primary (P) or Secondary (S) waves.

Convection –Movement in a gas or liquid in which the warmer parts move up and the colder parts move down. Magma (molten, fluid-like rock) in the mantle moves in convection currents--a circular wheel-like pattern. This is what moves the tectonic plates floating on the mantle. The following video is a great explanation of convection and how it affect plate movements.

- https://www.youtube.com/watch?v=jkKlGXG4lG8

Convergence boundary (zone) – When two plates move toward each other and collide.

Core – The center of the planet. Is composed of a liquid, molten outer core and a dense, solid inner core.

Crust – The first ten miles of the earth's surface. It is the outermost layer of the planet. The crust is brittle, thin and floats on the mantle.

Divergent boundary (zone) – When two plates are moving apart. This can create volcanoes.

Earthquake – Earthquakes happen when the moving tectonic plates that make up the surface of the Earth move apart collide, or slide under each other.

Epicenter – the point on the earth's crust directly above the earthquake's surface is called the epicenter.

Fault – A break between plates in the lithosphere creates a plate boundary between plates. This is where the build-up of energy happens that eventually leads to an earthquake.

Focus (hypocenter) – Where the actual fault line slippage occurs. This is the exact origin of the earthquake below the earth's surface.

Foreshock – Smaller earthquakes that precede larger earthquakes.

Lithosphere – The lithosphere is a combination of the upper mantle and the crust--the outer part of the solid earth composed of rock. It is about 60 miles thick. The lithosphere is broken into tectonic plates whose movement cause earthquakes.

Mantle – The part of the planet that is located between the crust and core of the planet.

P-wave – Primary waves. These are seismic body waves. These are the first waves to arrive during an earthquake. They are a type of compression wave. This means that they move forward and backward. These waves move very fast. They can move through solids, liquids and air. P-waves can be explained in the link below:

- http://www.geo.mtu.edu/UPSeis/waves.html

Phenomenon - a fact or situation that is observed to exist, especially one whose cause or explanation is in question.

Plate tectonics – The theory of the mass movement of rock layers in the lithosphere. These plates move by means of convection.

Scientific modeling - is a generation of a physical, conceptual, or mathematical representation of a real phenomenon that is difficult to observe directly. An example would be creating a small model that shows how tectonic plates move. A model would make it easier to observe this process because tectonic plates are typically very large and in parts of the world that we cannot observe.

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S-wave – Secondary waves. These are seismic body waves. They create the wave like feature of body waves. They move slower than the P-wave. They are very destructive. They cause the earth to move up and down during an earthquake. They only travel through solids. S-waves can be explained in the link below:

- http://www.geo.mtu.edu/UPSeis/waves.html

Seismic wave – Energy waves released from a fault line slip. This is what causes the ground to shake.

Subduction boundary – Formed when one plate slides under another plate.

Surface waves – These are the waves that cause movement on the Earth's surface. They are a product of P and S waves. There are two types of surface waves: Love (L) and Rayleigh (R). L-waves shift the ground back and forth while R-waves create a rolling motion. Surface waves can be explained by the link below:

- http://www.geo.mtu.edu/UPSeis/waves.html

Tectonic plates – In the lithosphere of the planet, there are plates of rocks. These plates are continuously moving due to convection currents. Movements of these plates are responsible for continental drift, formation of mountains, volcanoes and even earthquakes.

Transform boundary (zone) – When two plates horizontally slide past each other. An example is the San Andreas fault.

B. Modeling Examples – Online Resources

Type of model	Website URL	Website Description
Layers of the Earth	https://www.youtube.com/watch?v=28GNJsXp6Mk	The first 2 minutes of this video show a nice model of both relative size and layer properties for the core, mantle and crust.
	https://www.youtube.com/watch?v=dzm-VkphoGw	This is a less healthy food model that challenges students to think about the properties of the layers when they select representative materials.
Plate Tectonics	https://www.youtube.com/watch?v=28GNJsXp6Mk	From 1:56-2:56, this video shows a simple plate tectonic model using an orange.
	http://maggiessciencecconnection.weebly.com/mantle-convection-plate-tectonics-earthquakes--volcanoes.html	More advanced students might also think about modeling convection currents with a model such as that shown in the first video or with a lava lamp or hot cocoa model demonstrated in the third video.
Faults and Boundaries	https://www.youtube.com/watch?v=28GNJsXp6Mk	The orange model from 1:56-2:56 demonstrates boundary types. Starting at the third minute of this video, blocks are used as a model to demonstrate faults.
	http://maggiessciencecconnection.weebly.com/mantle-convection-plate-tectonics-earthquakes--volcanoes.html	This page includes a lot of helpful background information and videos. Once students understand different boundary types, challenge them to think about how they might use their hands or perhaps bread or other clay to demonstrate the interaction of plates and what happens at different types of boundaries.
	http://www.earthsciweek.org/forteachers/faults_cont.html	Explains how to create models of faults and boundaries using the materials in the materials section of this lesson plan.

Epicenter, Earthquake Focus and Seismic Waves	https://www.youtube.com/watch?v=QT7CN-WAR3c	Shows how to model seismic waves using a Slinky and a bowling ball.
How to model different geologic events	http://little-blossoms-childminding.blogspot.ca/2013/03/earth-science-structure-of-earth-and.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed:+blogspot/cfel+(Little+Blossoms)	Shows some great low-tech ways to model different geologic events.

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