**Subject: Earth Science**
**Topic: Earth's Crust and Earthquakes**
**Multi age groups (2nd – 6th grade)**
**Instructional Methods:**
**Direct Instruction**
**Inquiry and Discovery**
**Time Frame:** Best if covered in a mini unit over 3 or 4 days – 45 to 60 min. lessons each day.

**Rationale:**

Young children are naturally interested in everything they see around them--soil, rocks, streams, rain, snow, clouds, rainbows, sun, moon, and stars. During the first years of school, they should be encouraged to observe closely the objects and materials in their environment, note their properties, distinguish one from another and develop their own explanations of how the Earth, Earth systems and natural objects develop and change over time. Children should have opportunities to observe rapid changes, such as the movement of water in a stream, as well as gradual changes, such as the erosion of soil and the change of the seasons. In addition, students need to study natural disasters and steps scientists may take to decrease damage caused by these disasters

One of the most frightening and destructive phenomena of nature is a severe Earthquake and its terrible aftereffects. An Earthquake is a sudden movement of the Earth, caused by the abrupt release of strain that has accumulated over a long time. For hundreds of millions of years, the forces of plate tectonics have shaped the Earth as the huge plates that form the Earth's surface slowly move over, under and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free. If the Earthquake occurs in a populated area, it may cause many deaths and injuries and extensive property damage. Learning about this natural occurrence will decrease misconceptions about plate tectonics and increase students' understanding of natural disasters and how the Earth works.

**Goals:**
Students will learn:

The basics of how Earthquakes work and why they occur
The importance of high-quality construction in Earthquake zones
The political aspects of Earthquake preparedness and cleanup
What we can learn from previous Earthquakes and how these lessons can help us prepare for future Earthquakes

Virginia Standards of Learning

**Scientific Investigation, Reasoning, and Logic**

4.1 The student will plan and conduct investigations in which
- a) distinctions are made among observations, conclusions, inferences, and predictions;
- b) hypotheses are formulated based on cause-and-effect relationships;
- c) variables that must be held constant in an experimental situation are defined;
- d) predictions are made based on data from picture graphs, bar graphs, and basic line graphs.

The student will plan and conduct investigations in which
- a) observations are made involving fine discrimination between similar objects
- b) precise and approximate measurements are recorded;
- c) scale models are used
- d) hypotheses are stated in ways that identify the independent (manipulated) and dependent (responding) variables;
- e) a method is devised to test the validity of predictions and inferences; one variable is manipulated over time, using many repeated trials;

**Earth Patterns, Cycles, and Change**

5.7 The student will investigate and understand how the Earth's surface is constantly changing. Key concepts include
- a) Earth history
- b) the basic structure of the Earth's interior;
- c) plate tectonics (Earthquakes and Volcanoes);

Objectives:

The student will be able to construct a house and test the house for stability using a shake table.

The student will be able to verbally explain the Earth's plates and how they move providing at least two accurate facts.

The student will be able to verbally explain why Earthquakes occur.

The student will be able to identify the layers of the Earth; identifying at least three of the layers correctly.

OVERVIEW
Explore Earthquake hazards and damage to buildings by constructing model buildings and subjecting the buildings to ground vibration (shaking similar to Earthquake vibrations) on a small shake table. The buildings are constructed by two- or three-person teams of students. After construction, subjecting them to Earthquake shaking to see which designs of buildings and constructions are successful. Comparison of the results of

the building contest with photographs of Earthquake damage is used to reinforce the concepts of building design and Earthquake risk.

**Procedure**

9:00-9:05 Gather students in a group. Whole group instruction using direct instruction is the method used for the first part of the lesson. This part of the lesson is brief; the hands-on activities are critical to the learning process.

Advance Organizer

| | | |
|---|---|---|
| 9:05 – 9:20 | video – Bill Nye Earth's Crust | |
| 1ST Clip | 2:33-4:40 | Earth Model (2 minutes) |
| 2ND Clip | 12:48-14:50 | Plate tectonics (2 minutes) |
| 3rd clip | 17:55-20:14 | Earthquakes (3 minutes) |
| 4th clip | 20:50 | Earth's Crust music video (2 minutes) |

9:20 – 9:45 Whole group Earthquake talk – see Power Point presentation
9:45 – 10:05 **Clicker questions activity – see Power Point Quiz**
10:05 – 10:10 Break into two groups: approximately 2-4 grades and 5-8 grades

10:10 – 10:50
**Group A: Globe activity**

**Advance organizer**: Break students into small groups. Give each group an apple and butter knife. Have the students cut the apple in half and have students discuss what they observe. Talk about how the apple might be like the Earth.

Make clay models of the Earth. Give the students small balls of clay in red, blue, green, and yellow. Have the students roll the red clay into a ball about 1" in diameter (inner core). Cover the red ball with a layer of green clay (outer core). Cover the green ball with a layer of blue clay (mantle). Cover the blue clay with a thin layer of yellow clay (crust). Use a plastic knife to cut the model in half. Have each student name the layers of the model to a partner. When observing the layers after cutting discuss how the clay is uneven in parts. Ask, "Do you think that the Earth's crust is uneven in parts as well?"

Students will draw a cross-section of the Earth including the four layers and accurately label the four parts (crust, mantle, inner).

**Group B: Shake table activity**

**Note:** Shake tables can be built ahead of time by the teacher, or as a class activity.

**Advance organizer**: Discuss with the students constructing a stable house. Explain how engineers and architects take into account the danger of Earthquakes when they design houses and other buildings. Explain that new house designs are tested using gigantic shake tables.

The students are divided into groups of 3-5 and given materials for building a house. Explain the building rules (the house must have a roof, a floor, walls etc.). Students have 20 minutes to build and decorate their houses. The whole group will then gather and each house will be tested with the shake table. In addition each group's work is judged based on the stability of the house and the house's design - see Earthquake Damage Judging Criteria.

10:50 – 10:55 transition
10:55 – 11:55 group B: globe activity in gym
Group A: shake table activity and judging

**Materials four house construction**

Earthquake table (see diagram)

1 cm (3/8 inch) thick plywood

springs (relatively stiff unity compression spring, e.g., product number C-756, Lowe's)

spray paint (use a well ventilated area – outdoors if possible)

self-adhesive Velcro strips

Glue gun

Glue sticks

Small screw-in hooks

Thick string

Apples and plastic knives (for Earth layers introduction)

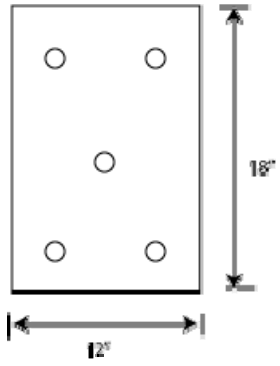
**Materials for Earth model**
4 different colors of play dough enough for each student to make a model of the Earth's layers

**Materials student groups will needed for house buildings**

Variety of paper (all different colors)
Washers (used to weight down house)
Paper clips
Styrofoam pillars

*Procedure for building tables:*

1. Cut the plywood into pieces of size 30.5 x 45 cm (12” x 18”); two pieces are needed per table (top and bottom).




2. Drill five 0.3 cm (1/8 inch) deep holes: one near each corner and one in the middle, on both plywood pieces. Each hole has diameter slightly larger than the diameter of the spring to be used.
3. Fit each spring in the holes on the bottom piece of plywood and glue with the hot glue gun; let dry for a few minutes. Fit the top of the springs into the holes of the top piece of plywood, and glue with the glue gun.

4. Let the glue dry for a few hours.
5. Paint the shake tables in well ventilated area.
6. Cut three pieces of Velcro (3 x 3 cm each) and stick one side to the top of the shake table. Students will attach the other side to the bottom of the floor.
7. Screw the hook to one side of the finished shake table; tie a piece of string to it.

Bill Nye The Science Guy Video: Earths’ Crust

Quiz Questions: Use questions from the posted Power Point Quiz or from state released end of year tests. This will give the students practice with question format and content.

Earth’s layers coloring sheet (optional)

**Resources**
Teacher Idea Books

"Janice VanCleave's Earthquakes." (New York: Wiley, 1993)
Children's Books
Planet Earth/Inside Out, Gail Gibbons. (1993).
Earth's Crust (Early Bird Earth Science), Conrad Storad. (2007).

A Journey to the Center of the Earth – a Wishbone story. (Jules).

**Web resources**

World-wide Earthquake Locator
http://tsunami.geo.ed.ac.uk/local-bin/quakes/mapscript/home.pl

Weather

http://www.weatherwizkids.com/Earthquake1.htm

Journey to the Center of The Earth

http://www.fi.edu/fellows/fellow4/nov98/

US Geological Survey

http://www2.nature.nps.gov/geology/usgsnps/pltec/pltec1.html

3D Earth Model Structure

http://web.ics.purdue.edu/~braile/edumod/threedEarth/threedEarth.htm

The Earth's Crust

http://mediatheek.thinkquest.nl/~ll125/en/crust.htm

Content Information for Teacher Use

***Crust***

The crust is the thin, solid, outermost layer of the Earth. The crust is thinnest beneath the oceans, averaging only 5 kilometers thick, and thickest beneath large mountain ranges. Continental crust (the crust that makes up the continents, of course!) is much more variable in thickness but averages about 30-35 km. Beneath large mountain ranges, such as the Himalayas or the Sierra Nevada, the crust reaches a thickness of up to 100 km.

Earthquakes cause the Earth to shake! A fault line located under the surface of the Earth causes earthquakes. You do not have to be right on top of a fault line to feel an Earthquake. You could be miles away and still feel the rattling of the Earth! Most Earthquakes only last for less than one minute. They cannot be predicted before they happen.

You can always tell an Earthquake is coming because the ground will begin to shake. You might see things fall off your shelves. Your door may rattle and shake! If it is a strong Earthquake, you might hear low rumbling noises. You will feel strong jerks as the Earth moves unexpectedly.

**Mantle**

The layer below the crust is the **mantle**. The mantle has more iron and magnesium than the crust, making it denser. The uppermost part of the mantle is solid and, along with the crust, forms the **lithosphere**. The rocky lithosphere is brittle and can fracture. This is the zone where Earthquakes occur. It's the lithosphere that breaks into the thick, moving slabs of rock that geologist's call **tectonic plates**.

As we descend into the Earth temperature rises and we reach part of the mantle that is partially molten, the **asthenosphere**. As rock heats up, it becomes pliable or 'plastic'. Rock here is hot enough to fold, stretch, compress, and flow very slowly without fracturing. Think about the behavior of Silly Putty® and you have the general idea. The plates, made up of the relatively light, rigid rock of the lithosphere actually 'float' on the denser, flowing asthenosphere!

Scientists' use something called a Richter scale to figure out how bad an Earthquake really is. Earthquakes below 2.0 are secret Earthquakes. The reason they are secret is most people cannot feel them. Earthquakes that are below 4.0 on the scale are small Earthquakes. These Earthquakes do not normally cause any damage. If the scale hits 5.0 then there could be damage. At 6.0, the Earthquake is becoming very dangerous. It is considered "strong". If the Earthquake reaches 7.0 it is a full blown, major Earthquake.

Earthquakes shake some buildings more than others. Earthquakes cause the ground to vibrate, which means that it moves back and forth. The number of vibrations per second that the ground moves is the frequency of the motion. The frequency of the shaking causes some buildings to vibrate more than others. This is because all objects have a

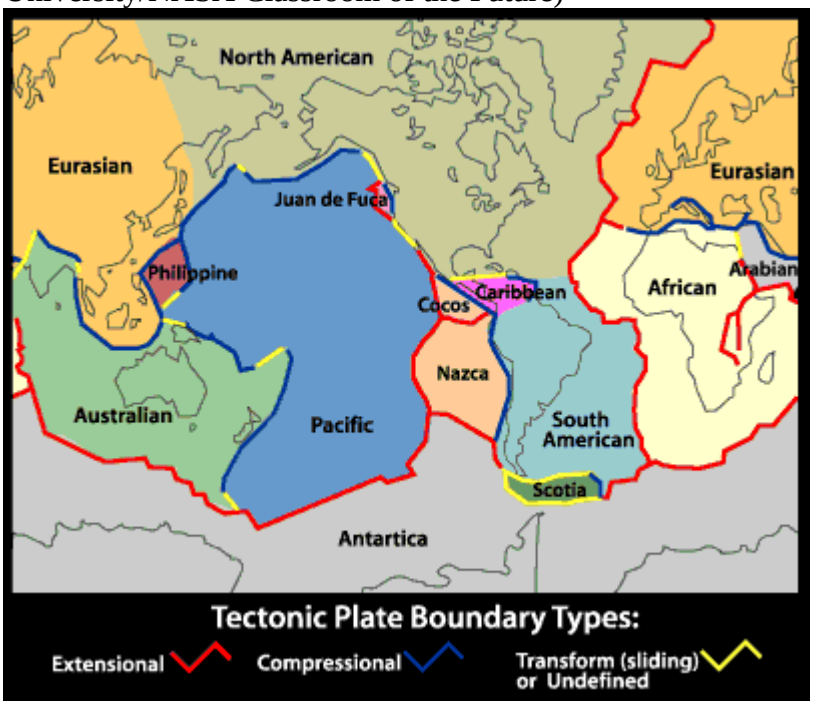
natural frequency at which they vibrate. When the frequency of the Earthquake matches the natural frequency of a building, resonance occurs, and that building will shake more than others.

**Core**

At the center of the Earth lies the super-dense core. With a diameter of 3486 kilometers, the core is larger than the planet Mars! The core of the Earth is made up of two distinct layers: a liquid outer layer and a solid inner core. Unlike the Earth's outer layers with rocky compositions, the core is made up of metallic iron-nickel alloy. It's hard to imagine, but the core is about 5 times as dense as the rock we walk on at the surface!

**What causes an Earthquake?**

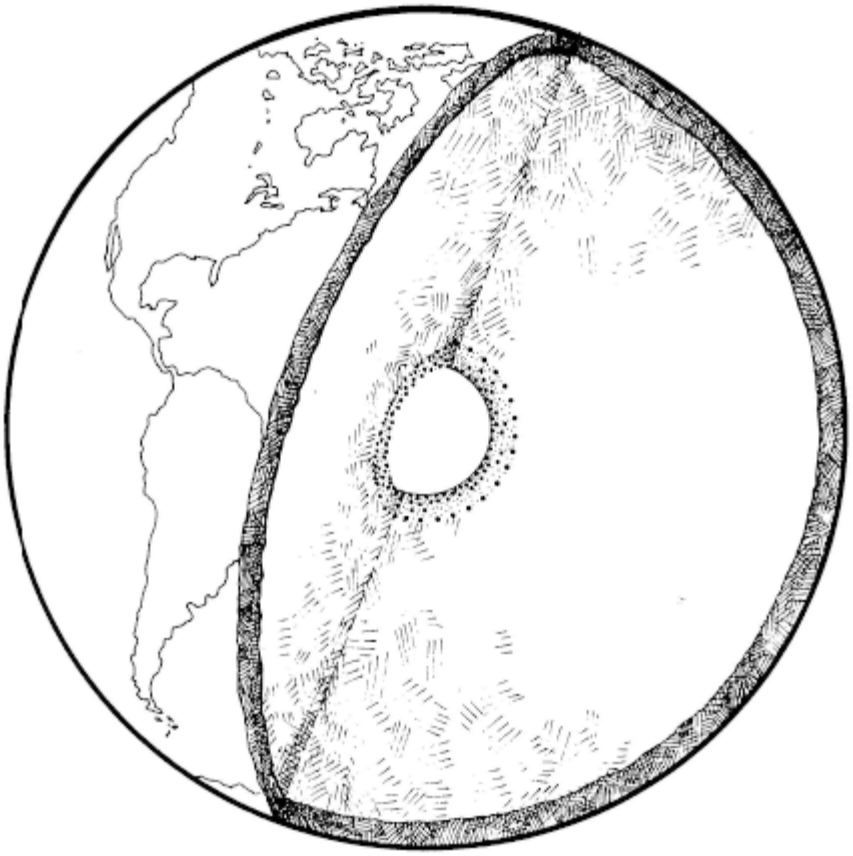
There are about 20 plates along the surface of the Earth that move continuously and slowly past each other. When the plates squeeze or stretch, huge rocks break at their edges and then shift with great force, causing an Earthquake. Think of it this way: Imagine holding a pencil horizontally. If you were to apply a force to both ends of the pencil by pushing down on them, you would see the pencil bend. After enough force was applied, the pencil would break in the middle, releasing the stress you have put on it. The Earth's crust acts in the same way. As the plates move they put forces on themselves and each other. When the force is large enough, the crust is forced to break. When the break occurs, the stress is released as energy, which moves through the Earth in the form of waves, which we feel and call an Earthquake. (Graphic Credit: Wheeling Jesuit University/NASA Classroom of the Future)



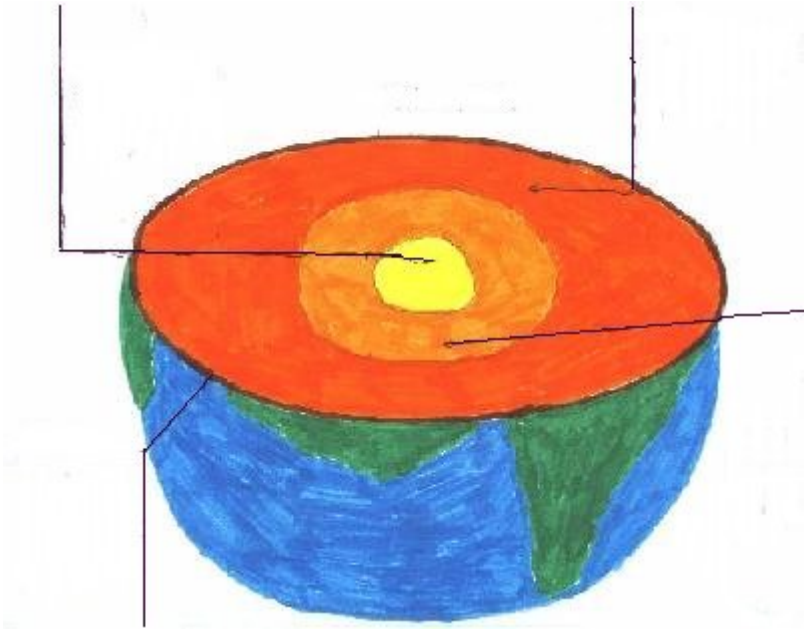

From Discovery Channel.com

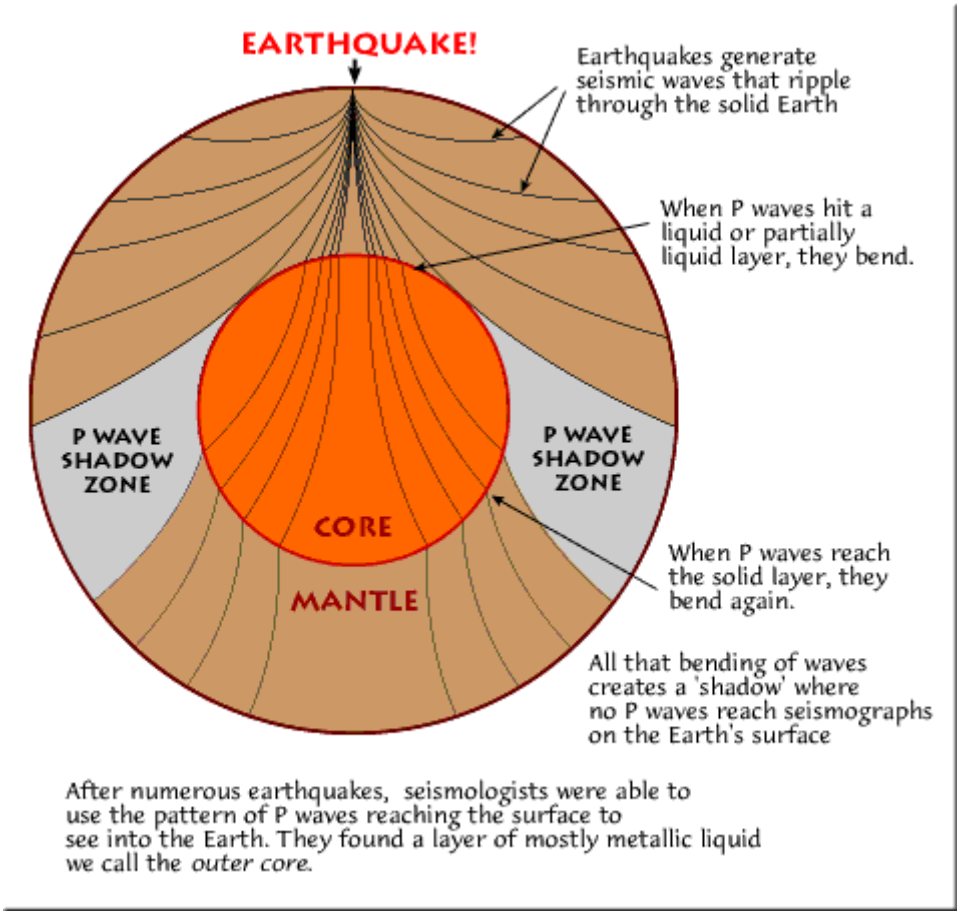
# The Earth

The Earth is more than just the oceans and the continents. Under your feet are four layers: the crust, the mantle, the outer core, and the inner core. Color the picture below to show the layers of the Earth. Use a different color for each layer and then label them.



water
land
crust
mantle
outer core
inner core






After numerous earthquakes, seismologists were able to use the pattern of P waves reaching the surface to see into the Earth. They found a layer of mostly metallic liquid we call the *outer core*.