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**Lesson Title:**

Evidence for plate tectonics adapted from “Discovering Plate Boundaries” developed from Rice University

<http://plateboundary.rice.edu/>

**Objectives:**

You will analyze data from various maps to discover the locations and the boundaries of Earth’s tectonic plates and what happens at plate boundaries.

**Science Content:**

- Earth’s surface is made up of plates (including: characteristics of plates, plates abut one another, number of plates, how continents and ocean floor relate to plates, etc.).
- Earth’s plates move around, and because plates abut other plates, they interact with one another along their boundaries.
- Plate interactions result in interesting and observable geological features and events (including: earthquakes, volcanoes, deep sea trenches, mid-ocean ridges, mountain ranges, etc.).
- Plate material is recycled (including: new plate material is added in some places, some plate material is removed from Earth’s surface in other places).

**State Standards:**

3.3.7.A3 - Explain and give examples of how physical evidence such as fossils and surface features of glaciations support theories that earth has evolved over geologic time. Compare geologic processes over time.

3.3.6.A1 - Recognize and interpret various mapping representations of earth’s common features.

S8.D.1.1 - *Assessment Anchor*. Describe constructive and destructive natural processes that form different geologic structures and resources.

**Materials:**

b & w transparencies of plate boundary maps (1 per group)

b & w copies of plate boundary maps (1 per group)

colored copies of data maps: Geochronology, Geography, Volcanology, Seismology (1 set per group)

colored copies of data maps downloaded for projection *or* 24” by 36” copies mounted on the walls

**Misconceptions:**

- Earthquakes and volcanism are related to warmer climates and to the ocean, rather than plate boundaries.

**Plates**

- Plates stack like dinner plates in a kitchen cabinet.
- A continent is a plate; plates are the same shape as the continents.
- Continents have no relationship to the plates.
- The plates are under the oceans, but do not include the continents.

### **Plate interactions result in events and features**

- The plates move, but they have no effect on one another.
- There is no way to determine the location of boundaries between plates.
- Erosion is the only process that alters the appearance of Earth.
- All changes to Earth's surface occur suddenly and rapidly.
- All events that affect Earth are gradual or slow.
- All Earth processes operate at the same rate (on the same time-scale).
- All changes to Earth occur so slowly that they cannot be detected during a human lifetime.
- Earthquakes, volcanoes, and mountain formation usually occur in the same general areas, but there is no explanation for this.
- Volcanoes and earthquakes always occur at or near plate boundaries. They cannot occur in the interior of plates.
- When two plates come together, non-volcanic mountains always form.
- Earthquakes are caused by plates crashing into each other. The bigger the crash, the bigger the earthquake.
- Mountains form when earthquakes push the ground up.
- Earthquakes occur most frequently along coastlines, without regard to the location of plate boundaries.
- Earthquakes cause all volcanic eruptions.
- Volcanic eruptions cause all earthquakes.

### **Recycling of plate material**

- "New" rock is created when a large rock is broken into smaller pieces—the smaller pieces are the "new" rock.
- All rock on Earth is the same age.
- New rock is added to plates only from the top when volcanoes spew out molten rock that solidifies into new rock on the surface of the plate.
- The subduction of plates means that Earth is becoming smaller.
- The continual formation of new rocks that are under the ocean (ocean floor) means that Earth must be getting larger.

### **Large Group:**

- Discuss all of the types of landforms found on Earth. Show various pictures of these landforms and their locations.
- Pose the question, "Why do these landforms appear where they do on Earth? Why don't we have a Grand Canyon, for example, in New Jersey? Why do we have earthquakes and volcanoes in certain places?"
- Gather student ideas on why they think these phenomena occur in the places they do. "Do you think there is a reason for this or does it just happen by chance? Why do you think that?" Students should record answers in their science journal.
- Discuss the common misconceptions that exist.
- Show each data map on the projector (or display the 24" by 36" colored copies, one at a time). Guide students to interpret each map, being sure that they understand what each map is showing. This should be brief.

### **Small Group:**

- Organize students into groups of 4. Assign jobs: Getter, Task Manager, Recorder, Reporter
- Distribute colored copies of the data maps to each group. Give them time to further analyze each map. Students should discuss any patterns they notice, any interesting observations, and any questions they have. The recorder should write down these points to share with the large group. (Approximately 10 minutes)
- Reporters will share their notes with the group.

### **Large Group:**

- Project and distribute copies of the b & w plate boundary map. Distribute copies of the transparency of the plate boundary map. Tell students to overlay the transparency on each of the data maps and record any patterns you recognize. Guide the class to understand that this map shows plate boundaries, and along the boundaries is where most of the volcanoes, mountains, and new rock activity occurs. Explain that these phenomenon are evidence that plates have boundaries and when the plates interact, these phenomenon occur along their borders.
- Present slides 1-11 from the powerpoint
  - <http://volcanoes.usgs.gov/about/edu/dynamicplanet/wegener/Tectonic>
- Ask students to refer back to their answers they recorded at the beginning of the lesson. They should make another journal entry clarifying the answer to this question: What is the mechanism that causes each of these phenomenon (earthquakes, mountains, volcanoes, rock formation) to occur?

### **Extra Resources:**

#### **Activities:**

- “Scientists have found that earthquakes occur more often in some places than others. Do you think there is a reason for this or does it just happen by chance? Why do you think that?”
- [Students were shown a world map and asked to look at Africa and South America.] “Do you see how the west coast of Africa and the east coast of South America look like they might fit together like a jigsaw puzzle? Do you think there is a reason for this or does it just happen by chance? Why do you think that?”
- “You seem to know something about Earth’s plates. Will you draw a side-view picture of what a plate looks like? What’s underneath the plate?”
- “If you wanted to go and touch a plate, where would you have to go?”

#### **Misconceptions:**

- “Pangaea broke apart a long time ago. Now the continents are coming back together on the other side of Earth. That’s what causes earthquakes—the continents bumping into each other.”
- “A giant meteor hit Earth, back when the dinosaurs were around. That killed off the dinosaurs and caused Pangaea to break up.”
- The plates are somehow “down there” - not really related to Earth’s surface.

### **Plate movement and plate interactions**

- Continents move by somehow floating across oceans.
- The continents float around on something—molten rock or water—like very large ships.
- All plates move in the same direction and at the same speed.
- Plate motion cannot be measured because it is so slow.
- If plates are moving apart two centimeters per year, that distance is so insignificant that it could never be noticed.
- Since the super-continent Pangaea split up ~200 million years ago, the continents have remained in essentially the same positions.
- Earthquakes caused Pangaea to break apart.
- The fact that the east coast of South America and west coast of Africa have shapes that would fit together like a jigsaw puzzle is just a coincidence.
- Continents (and plates) can never join together.
- Continents (and plates) cannot split and become smaller.
- It is impossible for the continents to have been parts of one large continent in the past.
- Plates are the same size and shape now as they've always been.
- When plates move toward one another, they fill a gap that once existed between the two plates.
- When plates move away from one another, a space between the two is created.
- The plates move so slowly that their interactions are insignificant.
- Continents do not move.
- After Pangaea broke apart, the continents moved around to the other side of Earth and will bump back into one another. (This bumping will lead to earthquakes.)