Georgia Performance Standards Framework for Earth Science – 6th Grade

Unit: Inside the Earth
Tiered Task
Plate Tectonics

Standards (Content and Characteristics):

S6E5. Students will investigate the scientific view of how the earth’s surface is formed.
   e. Recognize that lithospheric plates constantly move and cause major geological events on the earth’s surface.
   f. Explain the effects of physical processes (plate tectonics, erosion, deposition, volcanic eruption, gravity) on geological features including oceans (composition, currents, and tides).

S6CS3. Students will use computation and estimation skills necessary for analyzing data and following scientific explanations.
   a. Analyze scientific data by using, interpreting, and comparing numbers in several equivalent forms, such as integers and decimals.
   b. Use metric input units (such as seconds, meters, or grams per milliliter) of scientific calculations to determine the proper unit for expressing the answer.
   c. Address the relationship between accuracy and precision and the importance of each.
   d. Draw conclusions based on analyzed data.

S6CS5. Students will use the ideas of system, model, change, and scale in exploring scientific and technological matters.
   a. Observe and explain how parts are related to other parts in systems such as weather systems, solar systems, and ocean systems including how the output from one part of a system (in the form of material, energy, or information) can become the input to other parts. (For example: El Nino’s effect on weather)
   b. Identify several different models (such as physical replicas, pictures, and analogies) that could be used to represent the same thing, and evaluate their usefulness, taking into account such things as the model’s purpose and complexity.

Enduring Understandings:

- Lithospheric plates on the scale of continents and oceans constantly move.
- Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.
- Some changes in the earth’s surface are abrupt (such as earthquakes and volcanic eruptions) while other changes happen very slowly (such as uplift and wearing down of mountains).
Essential Question(s):

- How does the movement of lithospheric plates cause major events on earth’s surface?
- What evidence do scientists have that continents were once joined together?

Pre-Assessment:
Put chart paper out on tables or at the front of the room. On one piece, ask students to write or draw something they know about the Interior of the Earth. On another piece, ask them to write or draw something they know about Earthquakes. On another piece, ask them to write or draw something they know about Volcanoes.

Safety considerations:
There are no safety considerations for this lesson.

Materials required:
- Equipment for showing videos over the internet from United Streaming
- United Streaming password access
- World outline map for each student to write on
- Colored pencils or markers
- Several world maps with different types of projections from online sources or an atlas
- World globe
- Balls (softball sized) or small globes for each group of students
- Sheets of paper (plain computer paper or scrap paper)
- Scissors (optional) for cutting paper to fit ball/globe
- Maps and diagrams from various online sources (or textbooks) as mentioned in the lesson, below, including map of earthquake locations around the world, map of volcano locations around the world, map of tectonic plates, map showing location of 2004 Sumatra earthquake epicenter, map showing fossil evidence for plate tectonics, map and animation of the breakup of Pangea. (Web links are provided within the lesson to guide the teacher to the maps and other resources.)
<table>
<thead>
<tr>
<th>Outcome/Performance Expectation</th>
<th>BASIC</th>
<th>INTERMEDIATE</th>
<th>ADVANCED</th>
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<tbody>
<tr>
<td>Students will relate tectonic plate movements to the location of earthquakes and volcanic eruptions and understand these movements have an impact on humans.</td>
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<tr>
<td>Students will understand some changes in the Earth’s surface happen suddenly and without warning.</td>
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<tr>
<td><strong>Performance Task:</strong> (Detailed Description)</td>
<td><strong>Plate Tectonics</strong></td>
<td><strong>Students will participate in a “paired reading” of the information found below.</strong></td>
<td><strong>Students will read the information below independently.</strong></td>
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<tr>
<td><strong>Teacher role?</strong></td>
<td><strong>Part 1: Introduction to the effects of physical processes</strong></td>
<td></td>
<td><strong>Students can use the internet to search for additional articles on the eruption of Krakatoa.</strong></td>
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<tr>
<td><strong>Student role?</strong></td>
<td>Teacher shows video on tsunami from <a href="http://gpb.unitedstreaming.com">http://gpb.unitedstreaming.com</a> (see resources) or <a href="http://gpb.unitedstreaming.com/search/assetDetail.cfm?guidAssettlde=E5683237-CD3A-4582_850D-88D72C6F87BE">http://gpb.unitedstreaming.com/search/assetDetail.cfm?guidAssettlde=E5683237-CD3A-4582_850D-88D72C6F87BE</a></td>
<td>Basic students may read along as teacher reads the information found below to them or they could be engaged in a guided paired reading.</td>
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**Provide all students with this background information. Actual articles of the event could be found by advanced students prior to the introduction of the task or the teacher could locate additional articles on this event.**

On December 26, 2004, a tsunami occurred in the Indian Ocean following a great earthquake. A tsunami is a seismic sea wave, or a huge wave caused by an undersea earthquake.

The earthquake occurred off the coast of Sumatra (part of Indonesia). This was the fourth largest earthquake in the world since 1900, with a magnitude of more than 9 on the Richter Scale.
The tsunami killed more than 150,000 people and more than 1 million people lost their homes. The tsunami killed people not only in Indonesia, but also Sri Lanka, India, and in several countries in Africa, across the Indian Ocean.

The teacher needs to supply each student with a world outline map that they can draw and write on. The teacher also needs to supply several world maps (from online sources and/or from an atlas) and a globe.

<table>
<thead>
<tr>
<th>Student task:</th>
<th>Intermediate students should be able to locate the Indian Ocean, but may need to work in small groups, or may need assistance in locating Indonesia and/or Sumatra.</th>
<th>Advanced students should be able to locate all three places independently or working in small groups.</th>
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<tbody>
<tr>
<td>Locate the Indian Ocean, Indonesia, and the island of Sumatra on one or more world map AND on a globe. It is helpful to look at several different types of world maps and map projections. Basic students need assistance in locating Sumatra, and perhaps in locating the Indian Ocean.</td>
<td>Discuss the differences between using a map and a globe to locate Sumatra. Basic students may need to have the teacher direct the discussion and point out some of the differences between maps and the globe (i.e., discussing different map projections, and how a map is a two-dimensional representation of a 3-dimensional surface, and how there may be distortion toward the poles on a map.)</td>
<td>Intermediate students should be able to see the differences and discuss them as a group. Advanced students can discuss or write a paragraph about the differences. They can also research different map projections online.</td>
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</tbody>
</table>

The teacher should point out that maps and globes are different models that are used to represent the same thing (i.e., geography).
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<tr>
<th>The teacher should also note that there are several different types of <strong>map projections</strong>. (See online resources on “map projection” for examples.)</th>
<th>Intermediate students should be able to see that there is overlap on their own, or working in small groups.</th>
<th>Advanced students can take scissors and cut sections out of the paper map to make it fit the globe better, and then open them up to see what the resulting map looks like.</th>
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</thead>
</table>
| **Student task:**
Take a piece of paper and try to fit it to a globe (or a ball), covering the surface evenly. Discuss your success at producing a map that “fits” the globe evenly. | **Student task:**
- Label the location of Sumatra on the world outline map.
- Plot the location of the 2004 Sumatra earthquake **epicenter** with a red dot, using maps from online sources such as [http://geology.com/articles/tsunami-map.shtml](http://geology.com/articles/tsunami-map.shtml)
- Plot the locations of the countries around the Indian Ocean that were affected by the tsunami. | Intermediate students locate these features with some assistance, working in small groups. Advanced students can research the locations using online sources, and plot them on a map with minimal assistance. |
<p>| The student should note that there is “overlap” of the paper near the poles, and that the flat map does not cover the globe evenly. The teacher may need to point this out to basic students. | | |</p>
<table>
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<tr>
<th>d. Determine the distance in kilometers between the epicenter and the countries that were affected by the tsunami. In particular, find the distance between Sumat拉 and the countries in Africa. Record this information in the chart below for 5 countries.</th>
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<tbody>
<tr>
<td>The teacher can tell the basic students which countries were affected and help them locate and plot the locations on the map.</td>
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<tr>
<td>Using a tsunami travel time map, like the one on this page: <a href="http://geology.com/articles/tsunami-map.shtml">http://geology.com/articles/tsunami-map.shtml</a></td>
</tr>
<tr>
<td>Determine how many hours it took for the tsunami to reach the affected countries, particularly those in Africa.</td>
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<tr>
<td>The teacher will need to help basic students make the measurements.</td>
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<tr>
<td>Measurements should be made in metric units if possible (depends on the scale provided on the map that is used). Students can convert measurements in kilometers into meters or other metric units, as an option.</td>
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<tr>
<td>Intermediate students should be able to measure and make conversions with some assistance.</td>
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<tr>
<td>Advanced students can make the measurements independently. They may need to be shown how to convert metric to English and vice versa. Online metric converters are available.</td>
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</tbody>
</table>
The teacher should explain that scientific measurements are typically done using the metric system.

Teachers should provide the comparable distances in miles for students, as a reference.

Watch online tsunami visualizations in the Indian Ocean.

http://www.ngdc.noaa.gov/spotlight/tsunami/tsunami.html

http://serc.carleton.edu/NA GTWorkshops/visualization/collections/tsunami.html

http://www.ngdc.noaa.gov/sp otlight/tsunami/tsunami.html

Students can discuss why there were so many fatalities in these countries far from the epicenter, even though a number of hours had elapsed between the earthquake and when the tsunami struck the various places. (Hint – Why wasn’t there any warning that the tsunami was coming?)

The teacher will need to direct the discussion for basic students. There was

Intermediate students may be able to come up with some suggestions on why there were so many fatalities thousands of kilometers away.

Advanced students can offer suggestions and research possible reasons online.

Also research tsunami warning systems.
<table>
<thead>
<tr>
<th><strong>no tsunami warning system in the Indian Ocean at that time for a number of reasons (cost, lack of leadership, lack of coordination between governments, lack of communication system for citizens, etc).</strong></th>
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<tbody>
<tr>
<td>A tsunami warning system was created in the Indian Ocean after the 2004 event and became active in late June 2006.</td>
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<tr>
<td><strong>Was this the first time a tsunami struck the Indian Ocean? No.</strong></td>
<td><strong>Students can read in pairs.</strong></td>
<td><strong>Students can read independently.</strong></td>
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<tr>
<td>In fact, other geologic events can produce a tsunami, including explosive volcanic eruptions and asteroid impacts.</td>
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<tr>
<td>The teacher can read the story of the eruption of Krakatoa in 1883 from the BBC news website about the German quarry manager who survived being swept away in a tsunami: <a href="http://news.bbc.co.uk/1/hi/programmes/from_our_own_correspondent/4153109.stm">http://news.bbc.co.uk/1/hi/programmes/from_our_own_correspondent/4153109.stm</a> or from a similar article.</td>
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<td>The students can listen or read along with the teacher.</td>
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<td><strong>Note certain points that may or may not be in the article you read:</strong></td>
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<tr>
<td>The eruption of Krakatoa was heard thousands of miles away.</td>
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<td>The ash cloud rose so high into the stratosphere that it affected sunsets for more than a year.</td>
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<td>Volcanic eruptions can cause short-term climatic change (cooling).</td>
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With the assistance of the teacher, students use a reference map (such as the one in the article or another map of Krakatoa located online) and locate Krakatoa on a map or globe.

Students can attempt to locate the Krakatoa area independently using the reference map in the article (or another reference map), seeking assistance from peers or teacher as needed. Use a world map (perhaps several different projections) AND a globe.

Using the article (or a similar article on Krakatoa found online), students list the events occurring surrounding the eruption of Krakatoa.

Teacher can provide events in scrambled order, and have students organize them.

Events that need to be listed include:
Loud sound that was heard
Eruption of volcano with ash flying through the air

Students can list events by referring back to the article without a list.

Students can search online for other events associated with the eruption.
<table>
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<tr>
<th>Topic</th>
<th>Details</th>
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</table>
| Tsunami (4 waves) | Sunsets affected  
Climate change |

Students can refer back to the article as necessary.

**Discussion:**
Could a tsunami happen in Georgia, or along the east coast of the U.S.?

**References:**
http://www.ngdc.noaa.gov/mgg/inundation/  
http://www.erh.noaa.gov/erphi/reports/tsunami.htm  
(this reference includes the effects of the Krakatoa tsunami on the east coast of the U.S.)

Teacher leads discussion with basic students.

**Intermediate students contribute their ideas, guided by the teacher.**

**Advanced students can research this online and report to the class.**

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<tr>
<td><strong>Global patterns of earthquakes and volcanoes</strong></td>
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</table>
Teacher will provide students with two maps - one showing locations of **earthquakes** around the world and one showing locations of **volcanoes** around the world. (These maps can be found online or in a textbook). |

Teacher has already provided each student with a world outline map on which they can write or draw.

Students need colored pencils or colored markers.

Students transfer the locations of earthquakes to their outline map in one color and locations of volcanoes in another color.

Students can plot locations of earthquakes and volcanoes from latitude and longitude data that they obtain from online sources.
Students transfer the locations of earthquakes to their outline map in one color and locations of volcanoes in another color.

Teacher may need to prepare this map for basic students ahead of time.

Next, the students should connect the dots to outline the tectonic plates.

Teacher should give the students a map of the tectonic plates and ask them to transfer the outlines of the plates onto their world outline map.

Or give basic students a map of the plates and ask them to compare it with the maps of the volcanoes and earthquakes.

Teacher needs to point out that the movement of the Earth’s tectonic plates causes earthquakes and volcanic eruptions.


### The three types of plate movement

- Teacher points out the arrows on a tectonic plate map showing directions of plate movement.

- Students find an example of each type of plate motion on the tectonic plate map.

- Students find diagrams of the three types of plate motion online or in their textbook, and find a location in the
Examples of such maps:
http://piru.alexandria.ucsb.edu/collections/geosystems/geosystems11-17.jpg
http://www.geography.learnontheinternet.co.uk/topics/structureofearth.html

Teacher introduces the three types of plate tectonic movements:
- Divergent motion (the plates move apart)
- Convergent motion (the plates move towards one another)
- Transform motion (the plates slide side-by-side)

Good sources of information include:
http://pubs.usgs.gov/gip/dynamic/understanding.html
http://pubs.usgs.gov/gip/dynamic/Vigil.html

Teacher shows students block diagrams of the three types of motion.

Students find an example of each type on the map.

Students find an example of each type on the map with the assistance of peers or the instructor.

Teacher introduces additional evidence for plate tectonics, including fossil evidence and shows students where certain fossils are found.

Students find an example of each type on the map.

world where each is occurring. Advanced students can examine the difference between ocean-to-ocean convergence compared with continent-to-continent convergence and ocean-to-continent convergence and draw a sketch of a side view of each.
Example of a map with fossil evidence for plate tectonics:
http://pubs.usgs.gov/gip/dynamic/continents.html

Students cut out the plates (or continents) from a paper map, color them to match where the fossils are found, and slide them so that the places where the fossils are found come into contact with one another.

Students examine a map and animation of the breakup of Pangea.
Example of a map:
http://pubs.usgs.gov/gip/dynamic/historical.html

Examples of animations:
http://www.scotese.com/pangeanim.htm
http://www.ucmp.berkeley.edu/geology/tectonics.html
(from the beginning of the Mesozoic to the Recent).

Students predict what will happen in the future, as plate tectonic motion continues.

Students can check their predictions with an animation like this one:
http://www.scotese.com/future.htm

**Resources**

| Homework/Extension | Students can choose a currently erupting volcano and write a report on how it is related to plate | Advanced students could do a multimedia presentation on a volcano and the |
### Instructional Tasks Accommodations for ELL Students
- Use shorter sentences
- Paraphrase often
- Provide a word wall for difficult vocabulary
- Show videos from United Streaming
- Avoid “asides” when giving direct instruction about examples of the three types of plate movements
- Reduce the number of key points these students are responsible for knowing
- Extend the time to complete the task
- Seat student near teacher or positive role model during direct instruction and student-centered activity time

### Instructional Tasks Accommodations for Students with Specific Disabilities
- Provide guided practice as students identify examples of the three types of plate movements
- Have students collaborate with general education peers
- Use think-pair-share activities during direct instruction
- Reduce sources of distractibility such as multiple visual aids (ADHD)
- Break work into manageable parts
- Reinforce oral instructions with written instructions
- Use stabilized materials for students who have difficulty with mobility
- Use amplification equipment while exploring task with students who are DHH

### Instructional Tasks Accommodations for Gifted Students
- Use curriculum compacting as needed
- Students may construct their own graphic organizer based upon their depth of mastery
- Students will develop their own learning contract for the unit of study on plate tectonics based on the standard; be sure to provide content information and a variety of resources for students to use
- Negotiated product and assessment requirements
Let students function as mentors to others
Have these students lead the discussion part of the task; encourage them to prepare additional topics for discussion