Mary Sue Burns
Course/Grade: Earth Science 11th-12th
Topic: Geologic Hazards around the World
Course Concepts: Recognizing Perspectives; Call to Action
Frames for Global Learning: Environmental and Cosmopolitan

<table>
<tr><th colspan="3">Stage 1 Desired Results</th></tr>
<tr><td rowspan="4">ESTABLISHED GOALS

SC.O.E.1.5
draw conclusions from a variety of data sources to analyze and interpret systems and models (e.g., use graphs and equations to measure and apply variables such as rate and scale, evaluate changes in trends and cycles, or predict the influence of external variances such as potential sources of error, or interpret maps).

SC.O.E.1.6
investigate, compare and design scientific and technological solutions to address personal and societal problems.

SC.O.E.2.9
predict geologic activity associated with specific plate boundaries and interactions.

SC.O.E.2.10
analyze modern and historical seismic information to determine epicenter location and magnitude of earthquakes.</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">Students will be able to independently use their learning to…

T1: Analyze data to evaluate risks due to earthquakes and volcanoes in various parts of the world.

T2: Create a safety plan for residents of a location in a high risk of earthquake and/or volcanic activity.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS

Students will understand that…

U1: Earthquakes and volcanoes are associated with plate boundaries.

U2: There is a relationship between the type of plate boundary and the associated geologic activity.

U3: Earth materials are cycled as plates subduct and volcanoes erupt.

U4: Geologic hazards are unevenly distributed on the Earth’s surface and thus impact some parts of the world more</td><td>ESSENTIAL QUESTIONS

E1: How can geologic data be used to increase the safety of world populations?

E2: How does plate tectonics influence the surface features of Earth?

E3: What are the advantages and limitations to the application of scientific knowledge and data to public safety in the face of geologic hazards?</td></tr>
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SC.O.E.2.11 evaluate current explanations for mechanisms, which drive the motion of plates (convection, slab-pull, plate push). SC.O.E.2.26 compare the relationship between earth processes and natural disasters with their impact on humans. **Source: West Virginia Content Standards & Objectives for Earth Science** HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. **Source: Next Generation Science Standards for High School Earth Science.**	significantly than others.	
	Acquisition	
	Students will know… 1. The types of plate boundaries and associated tectonic events. 2. Theories for possible mechanisms of plate tectonics (convection, slab-pull, etc.) 3. Some regions of the world have been severely impacted by geologic hazards. 4. How to evaluated earthquake severity using the Richter Scale. 5. Layers of the Earth and relative densities of materials in each layer. 6. Historical and modern evidence of plate tectonics.	*Students will be skilled at…* 1. Accessing and analyzing worldwide earthquake and volcano activity.(Global Competence: Collect and synthesize data to compare a phenomenon in multiple locations.) 2. Using maps and graphics to represent earthquake and volcanic activity. 3. Using models to explain consequences of tectonic plate motion. 4. Comparing and contrasting geologic risks in various parts of the nation and world and communicating rationales for varied safety plans for different communities worldwide. (Global Competence: Discuss the broader implications of your research findings to you, your close circle, and other affected people.)

Stage 2 - Evidence	
Evaluative Criteria	**Assessment Evidence**
1. WVDE rubric for multimedia presentations with the following specific content criteria added: the degree to which geologic hazards have been identified for the given region; the degree to which the causes of geologic hazards in this region have been explained; the degree to which geologic and topographic features have been incorporated into the plan. 2. WVDE writing rubric will be used in addition to the degree to which the descriptions accurately depict possibilities in the selected region. 3. Checklist that all items are completed.	TRANSFER TASK(S): 1. **Safety Plan Presentation:** Students will collaborate as a group to create a presentation that outlines a safety plan to people of a selected region outside the United States. The presentation must include evidence of geologic hazards in this region and an explanation of why the plan is needed. (Global Competence: Prepare your project presentation to be delivered to a different audience – i.e. individuals affected by the topic you are discussing.) 2. **Letter Writing:** Imagine that you live on a plate boundary. You select the location and research the history of geologic hazards in this region. Write a letter to your pen pal in the United States describing your observations and experiences during a geologic event. 3. **Create a digital graphic organizer** about types of plate boundaries. For each type include: • A description and diagram of what is happening to the plates • A specific geographic location where this is occurring • Several pieces of specific data and the sources about geologic events at the location • A summary of a personal account from someone who experienced a geologic event at the location with the associated reference. (Global Competence: Document global events using a preferred mode of communication.)

4-9. The degree to which the assignments are accurately completed in a timely fashion. 10. Accuracy of answers.	OTHER EVIDENCE: 4. Journal and Analysis from SAS Curriculum Pathways "Plate Tectonics" Internet Activity. 5. Model and explanation of evidence for Pangea. 6. Model and explanation of magnetic polarity evidence in the sea floor. 7. Magnetic Polarity Lab Report. 8. Subduction Zone Lab Report. 9. Volcanic Hot Spot Investigation. 10. Test that includes interpretations of maps and diagrams, as well as predictions based on plate tectonics.

Stage 3 – Learning Plan

Summary of Key Learning Events and Instruction
(Each Lesson represents at least one 90 minute block or two 45 minute periods.)

Lesson 1: Introduction to geologic hazards and launch of team project. An entry event such as the viewing of news clips about geologic hazards around the world will be used to stimulate interest. In a launch of a project-based learning experience, student teams will be organized and presented with the challenge to collaborate as a group to create a presentation that outlines a safety plan to people of a selected region outside the United States. The presentation must include evidence of geologic hazards in this region and an explanation of why the plan is needed. (Organization of teams may include making a team contract for member accountability.) Student teams will work on this project throughout the unit. **Continental Drift and historical roots of the theory of Plate Tectonics.** Students will read and discuss the ideas of Alfred Wegener. They will examine historical evidence for the idea of continental drift and previous supercontinents like Pangaea. Students will participate in an activity in which they use historical evidence such as rock ages, fossil records, shapes of land masses, and glacial features to construct a model of a plausible supercontinent. Students will write a justification for their model. (SC.O.E.1.5, HS-ESS1-5)

Lesson 2: Evidence for Plate Tectonics: Magnetic Polarity and the Sea Floor. Students will participate in an activity to construct a model showing magnetism in sea floor rocks that is accompanied by an analysis of the meaning. Then students will examine actual data on magnetic polarities of rocks from several different mid-oceanic ridges. By correlating polarities, they will construct bar graphs to show the amount of spreading that occurred in each area over specific time periods. From this information, they will calculate and compare spreading rates for the regions. (SC.O.E.1.5, HS-ESS1-5, HS-ESS2-3)

Lesson 3: Patterns of Earthquake and Volcanic Activity: Further evidence of Plate Tectonics. Students will research specific locations of recent earthquakes and volcanoes and plot these on a world map. Analysis will include the identification of patterns and a comparison to Earth's plate boundaries. Student teams will select a country which has been the site of recent earthquake or volcanic activity to be the focus of further

research. (SC.O.E.1.5, SC.O.E.2.9, SC.O.E.2.10, HS-ESS2-3)

Lesson 4: Overview of Plate Tectonics. Students will complete the Plate Tectonics activity from SAS Curriculum Pathways (www.sascurriculumpathways.com). In this activity, students run simulations of events that occur at various types of plate boundaries, investigate the role of density in plate tectonics, and apply this to events at specific locations. After completion, students will create their own digital graphic organizer about types of plate boundaries. They will use this to identify the likely geologic activities at their selected country. (SC.O.E.2.9, SC.O.E.2.11, HS-ESS1-5, HS-ESS2-3)

Lesson 5: Subduction Zones. Students will construct graphs of earthquake depth versus latitude at several different subduction zones including the west coast of Chile and the Tonga Islands. If possible, student teams that have selected a country that borders a subduction zone should also graph data from their selected region. Students will then compare and contrast the depth of earthquakes, subduction angle, and subduction rate at these regions. They will then be asked to draw conclusions about the reasons for the differences based on concepts in the previous lesson. (SC.O.E.1.5, SC.O.E.2.9, SC.O.E.2.10, SC.O.E.2.11, HS-ESS1-5, HS-ESS2-3)

Lesson 6: Volcanic Hot Spots and Plate Motion. Students will explore maps of an island group which formed over a volcanic hot spot, such as Hawaii or the Galapagos. By noting the locations and ages of each island, students will describe the motion of the overlying plate, including its rate and direction, and make predictions about future island formation. (SC.O.E.1.5, HS-ESS1-5, HS-ESS2-3)

Lesson 7: Researching geologic events in a specific region. For a selected region/country, student teams will research the occurrence of geologic events over time. Each team will create maps and/or other graphics representing the frequency, extent, and severity of these events. (SC.O.E.1.5, SC.O.E.2.9, SC.O.E.2.10 , SC.O.E.2.26)

Lesson 8: Personal Accounts of Geologic Events. Each team will research first-hand accounts of people who have experienced specific geologic events. These can include published accounts as well as accounts obtained through direct communication. If possible, students should interview a person from their selected country. This could be an exchange student, a visiting scientist, or a community member who has been there. Interviews could be done by email, Skype, or other means. After review and discussion, each student will write a letter from the perspective of a resident of the selected country. The letter should be addressed to a pen pal (to their classmates, for example) in the United States and describe possible observations and experiences during a geologic event. (SC.O.E.2.9, SC.O.E.2.26)

Lesson 9: Safety Plans -The culminating product for the project based learning activity. Students will collaborate as a group to create a multi-media presentation that outlines a safety plan to people of a selected region outside the United States. (The presentation must include evidence of geologic hazards in this region and an explanation of why the plan is needed.) The presentation will be suitable for sharing as a means of promoting awareness of the importance of using scientific data to recognize patterns, make predictions, and formulate plans to promote human safety and well-being, world-wide. (SC.O.E.1.6 , SC.O.E.2.9, SC.O.E.2.10 , SC.O.E.2.26)

Lesson 10: Presentations and Peer Reviews. Students will share their presentations with other teams. Teams will be responsible for critiquing each others' presentations using a rubric. Teams will have the opportunity to make revisions. (SC.O.E.1.6, SC.O.E.2.9, SC.O.E.2.26)

Additional Activities and Resources:

How the Earth Was Made. This video series, by the History Channel, includes several episodes that are an excellent supplement to this unit. These especially include *The Ring of Fire*, *Mount St. Helens*, *Hawaii*, and *Krakatoa.* http://www.history.com/shows/how-the-earth-was-made

http://www.learner.org/interactives/dynamicearth/index.html Annenberg Learner. Interactives: Dynamic Earth. This is a great interactive tutorial about the structure of the Earth, plate movement and the consequences. Includes an assessment.

http://www.learner.org/interactives/volcanoes/entry.html Annenberg Learner Interactives: Volcanoes. This is an interactive tutorial about volcanoes.

http://nemo.sciencecourseware.org/eec/Earthquake/ Virtual Courseware: Earthquakes. Students locate Earthquake's epicenter and determine magnitude. Student journal can be printed out.

http://www.learner.org/courses/essential/earthspace/session3/classroom2.html Sample lesson that demonstrates the properties of Earth's interior using Silly Putty and Slinkies.

http://www.learner.org/workshops/geography/workshop2/wkp2less.html These are featured lessons for Latin America. One is about plate tectonics.

http://volcano.oregonstate.edu/ Volcano World. This website contains information about current eruptions, lesson/tutorials, virtual visits to volcanoes (Indonesian volcano includes info about people there), volcano folklore from around the world, etc.

http://earthobservatory.nasa.gov/NaturalHazards/category.php?cat_id=12&m=10&y=2013 NASA satellite imagery that shows results of natural hazards.

https://www.e-education.psu.edu/earth106/content/l1.html This is an earthquake lesson from the Penn State University Geosciences Department. The lesson focuses on earthquakes in Africa. It includes a human perspective, as well as the basic concepts of plate tectonics.

http://www.thirteen.org/edonline/lessons/volcanoes/b.html Are We Falling Apart? Exploding Volcanoes Lesson. This lesson includes internet activities as well as a hands-on component.

https://sites.google.com/site/varricchioseven/earthquake-pbl A PBL in which students make a safety plan for their school.