The Influence of Plate Tectonics on Our Ever Changing Earth

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Overview/Problem Statement: Using a key concept like plate tectonics to develop my unit plan, I intend to demonstrate how the movement of the earth's plates causes changes to the earth's surface through a series of investigations. The investigations will highlight the identification of the earth's layers, the plate movement, the formation of volcanoes and mountain ranges, the dynamic characteristics of volcanoes, and the geologic time scale as it relates to the earth land forms and organisms.

Target Students: I targeted this unit plan towards 2 audiences: first, the middle school group, who usually learn earth science as part of their 6^{th} grade curriculum, and second, the high school community because they often study earth science as a separate unit in environmental scienc Throughout this unit, the students will be involved in a series of teacher-led and student-led activities. (i.e. this unit will include some inquiry based ideas but will also include direct instruction.) Some of the learning styles that will be focused on here will be: tactile, visual, auditory, and others. Additionally, some strands of the curriculum that will overlap here with portions of the: math, art and English requirements for instruction. The purpose of the incorporation of cross-curricular strands and the utilization of different learning styles is to encourage all learners, through various modalities, to connect with the content.

Rationale:

Plate tectonics play a critical role in shaping the earth's surface. The nature of my coursework at Penn is centered around exploring the many forces of nature that play a huge role in that process.

So far, we have discussed glacial deposits and changes, plate tectonics and mass wasting. Knowing that there are many more topics to discuss, I decided to start with one fundamental concept that I could easily disseminate to my students as definitive proof that the earth is a dynamic place: plate tectonics.

Objectives:

Through this unit the students will engage in a variety of activities that will help them to better understand the dynamic earth. They will observe demonstrations, be party to various lectures on plate tectonics and most importantly engage in a series of investigations on the events that have and continue to influence the earth's surface. Generally speaking, after completion of this unit, students will be able to: demonstrate plate movement, identify the major events in geologic time, complete a Pangean puzzle, map out the ring of fire, and other specific skills. that will enable them to be able to explain the influence of events that have (and continue) to shape the earth's surface.

Background[1]:

Utilizing a plethora of materials, I plan to provide demonstrations leading to an understanding of the basic organization of the earth and it's tumultuous state. This unit will begin with a pre-class activity that asks the students prior knowledge on the earth's organization. (Please see the power point images attached). Students will then visualize the layers of the earth through the analogy of an egg. (This activity is cited and included, as well.) The purpose of this activity is to engage the learner and provide a fundamental building block for understanding. Next, I will use the egg demonstration to provoke a conversation regarding the earth's crust. For example, I intend to convey that the relatively thin crust of the earth is made up of various plates, which are shifting into diverse configurations to cause the development of mountains, volcanoes, and earthquakes. Next, I will review how the interaction of plates, and other natural events have influenced our understanding of evolution through the earth's surface. In other words, I expect to explain how we know that changes have occurred (i.e. studying rocks, and observing changes in the earth's surface after earthquakes, etc) to both the surface of the earth and it's inhabitants. Throughout the unit, students will: demonstrate plate movement, identify the major events in geologic time, complete a pangean puzzle, map out the ring of fire, etc. as well as the be guided through a series of lectures about these topics.

Strategies:

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[1] ***(Please note: Big Ideas are being discussed here, but the actual unit plan will have much more information)***

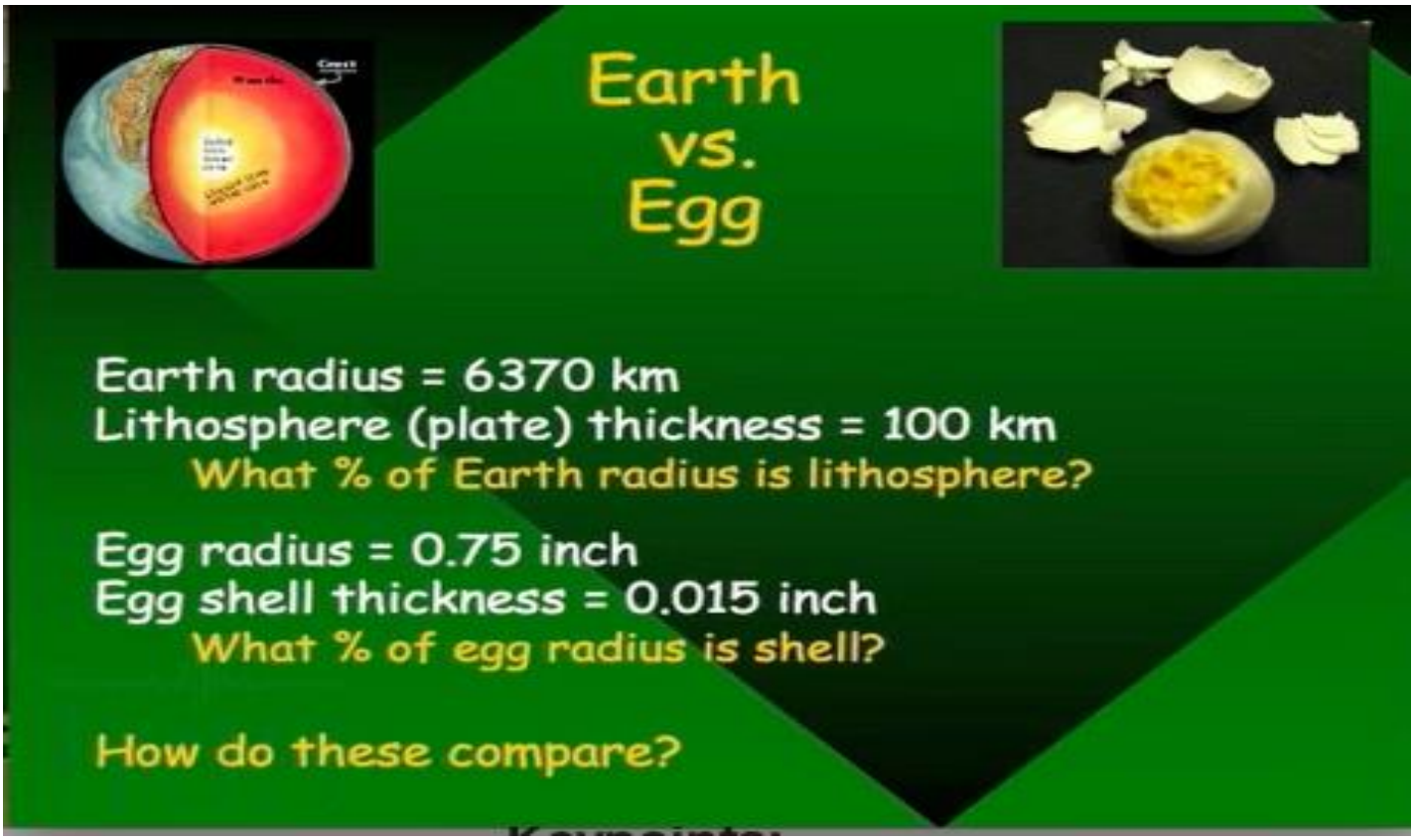
In this unit, the students will be involved in a series of teacher-led and student-led activities. (i.e. this unit will include some inquiry based ideas but will also include direct instruction.) Some of the learning styles that will be focused on here will be: tactile, visual, auditory, etc. Additionally, some strands of the curriculum that will overlap here with portions of the: math, art and English requirements for instruction. The purpose of the incorporation of cross-curricular strands and the utilization of different learning styles is to encourage all learners, through various modalities, to connect with the content.

Unit Organization (Rationale Continued):

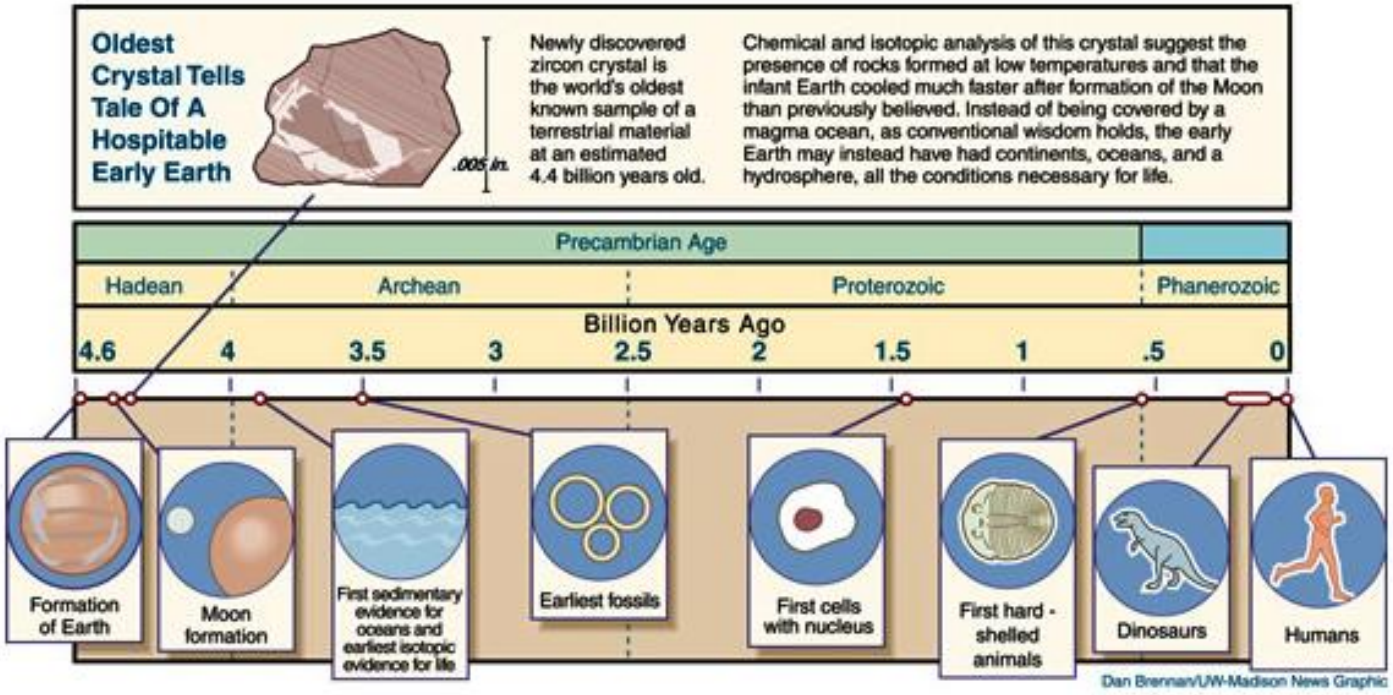
This unit will open with a hands-on activity.

1.The purpose of this opening exercise is to encourage engagement in the new topic, "the characteristics of the earth." In groups, the students will be drawing an analogous relationship between the earth and an egg. They will learn the layers of the earth, by connecting the physical object (egg) to the known characteristics, which I will review with the class through power point. Here is a video that describes this further…

http://www.iris.edu/hq/inclass/video/earth_vs_the_egg_measuring_earths_layers

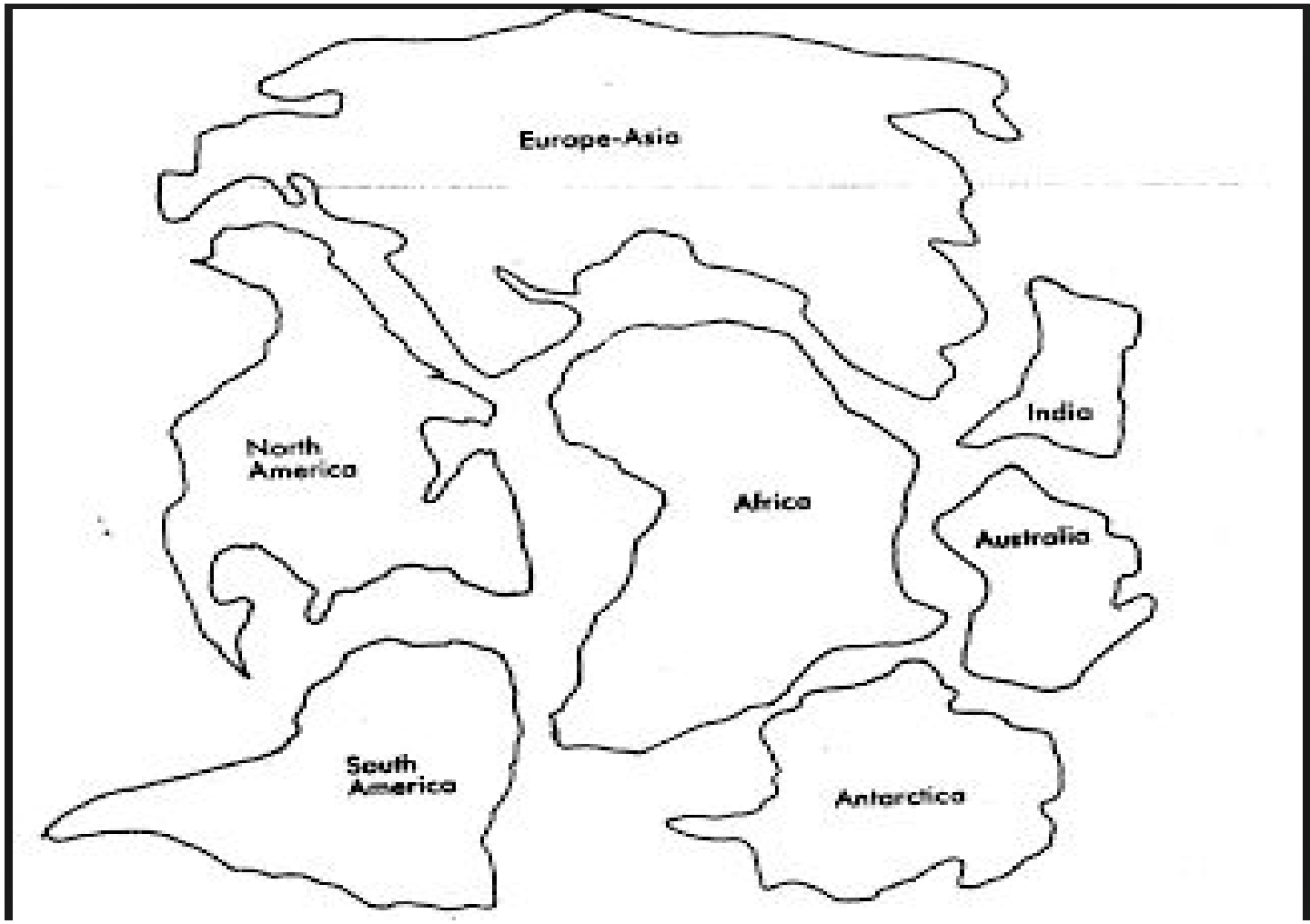


2. The second activity will begin by introducing the students to a geologic time scale that helps students to focus on the main events that sculpted the earth's evolution. Students will color code that image and be able to identify key events.



(Image taken from: http://darwiniana.org/geology.htm)

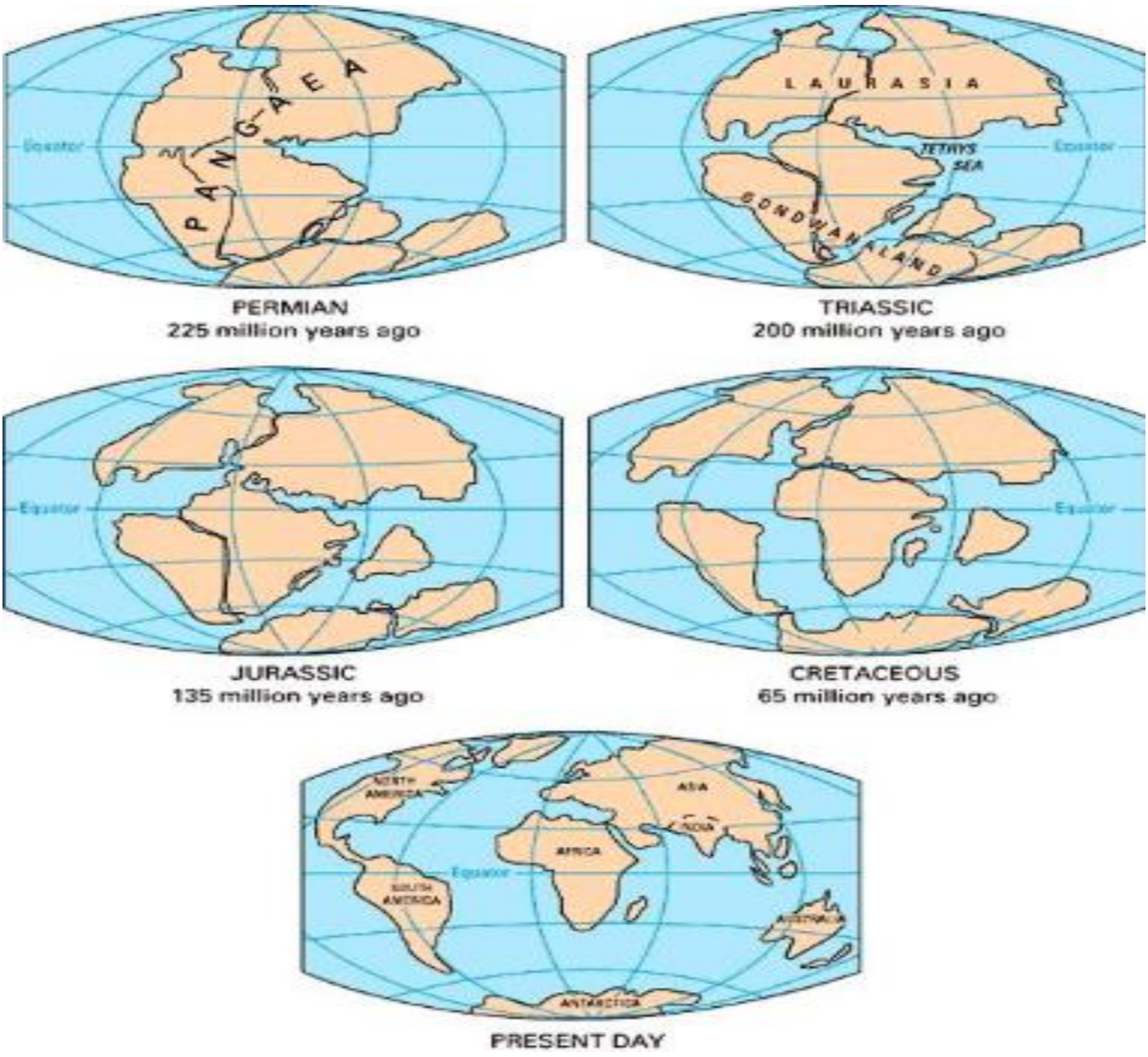
3. Next, in a similar fashion to the last lesson, the students will engage in an activity to explore the earth's crust. First through an assignment that involves identifying, color coding and cutting the different continents of the earth from a template then through a brief activity where those sections of the earth will be arranged (by the students) in an attempt to find the best fit for the land masses of the early earth.



(Image taken from: http://www.rocksinmyheadtoo.com/Pangea.htm)

Tectonic plates

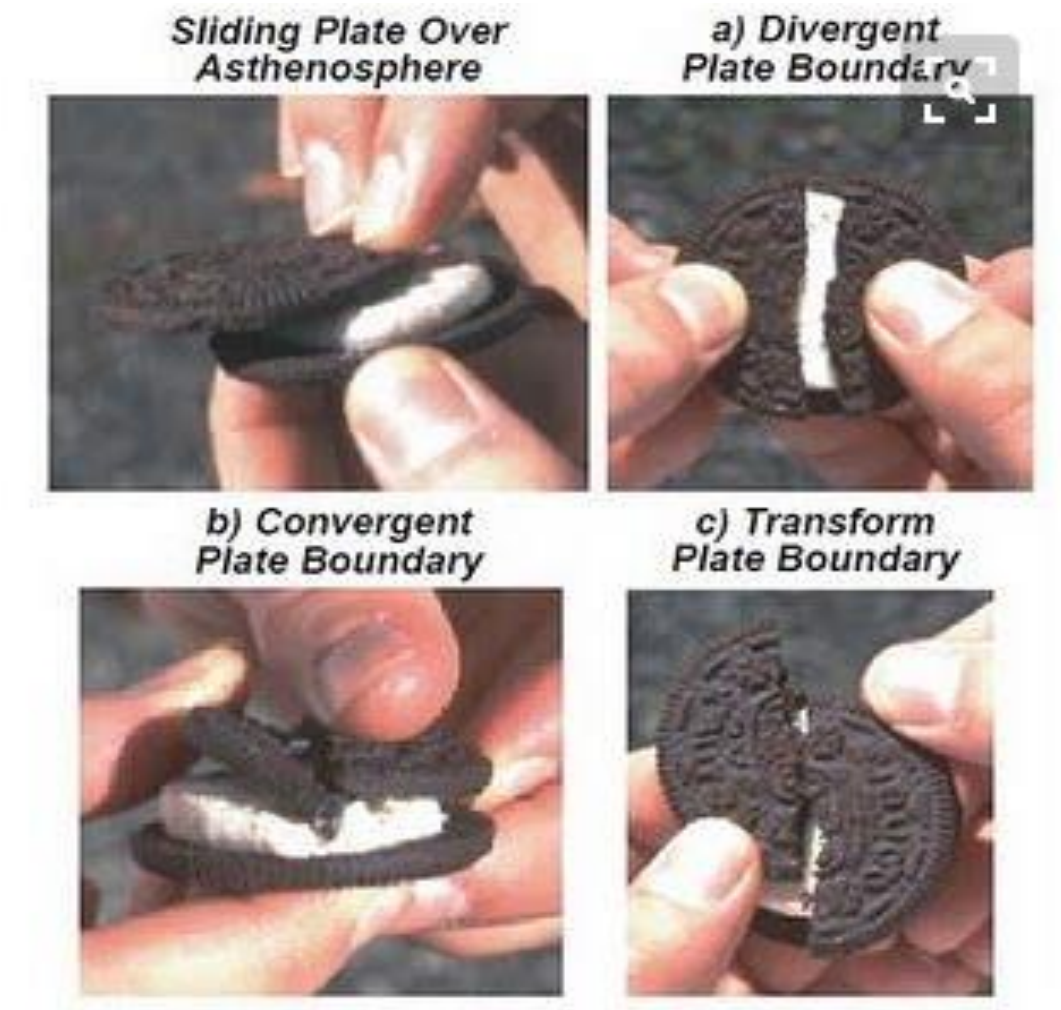
I will review the earth's characteristics, this time through the perspective of the pangean theory. In so doing, I will review the evidence we have that supports this theory, as well. This is when I will also introduce the concept of tectonic plates. Students will color code the continents and their movements here, as well.



(Image taken from: https://www.pinterest.com/pin/73042825182955075/activity)

Plate Movement

Utilizing the continental movement as a vehicle to describe continual changes, next, the students will explore the gradual and dramatic movement of the earth's tectonic plates through a simple hands on exercise that allows students to see the tectonic plate movement using a cookie to show the common structural changes that the earth endures. Here as an example:



(Images taken from: https://www.pinterest.com/pin/277604764501724992/)

The Ring of Fire

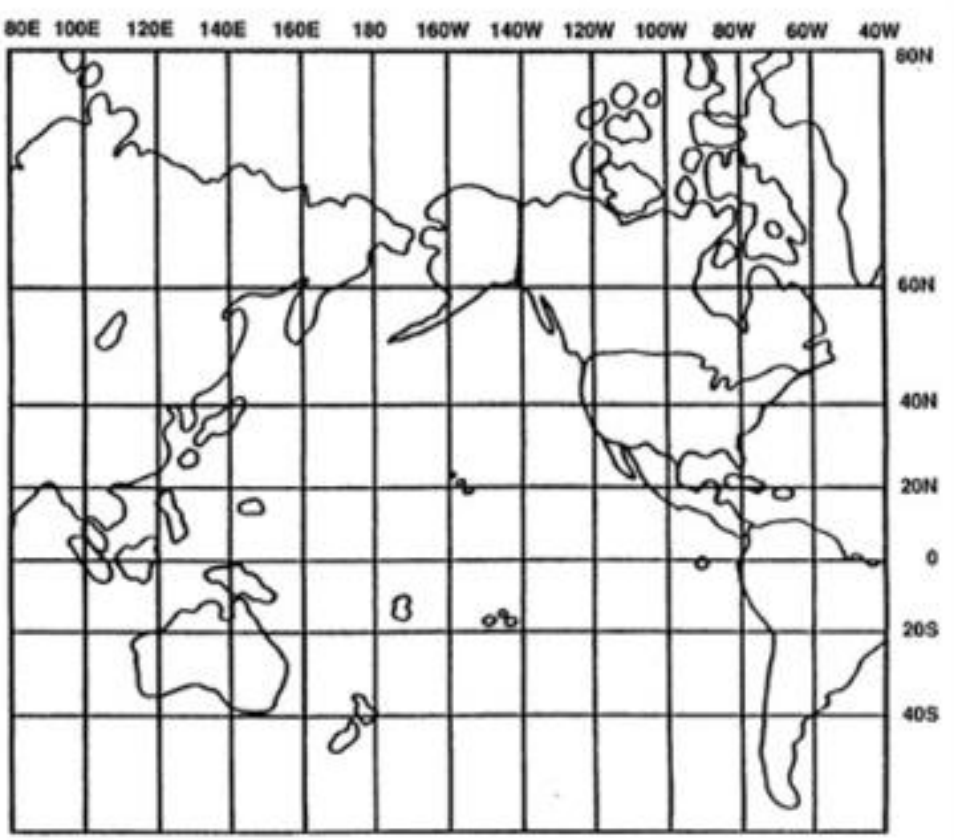
Lastly, as part of this introductory unit for earth science, I will have the students utilize their mapping skills to identify the "ring of fire" and note the tumultuous portions of the earth that are actively changing on our planet today. Through this mapping experience they will be able to gain practice using math and geographical skills. Additionally, I would site evidence of current events (i.e. Japanese and Ecuadorian earthquakes). Perhaps, I will supply a couple of news articles and ask the students to summarize them and report out their contents.

Procedure

Plot each volcano site using the latitude and longitude points provided below. Connect the points to create the Ring of Fire.

Location of volcano	Latitude	Longitude
Western United States		
Mount Rainier (Washington)	47°N	122°W
Mount St. Helens (Washington)	46°N	122°W
Crater Lake (Oregon)	43°N	122°W
Mexico and Central America		
Parkutin, Mexico	19°N	102°W
Popocatepetl, Mexico	19°N	98°W
Santa Maria, Guatemala	15°N	90°W
South America		
Misti, Peru	16°S	71°W
Alaska and eastern Siberia		
Katmai (Alaska)	58°N	155°W
Umnak Island (Alaska)	53°N	169°W
Kamchatka, Soviet Union	57°N	160°E
Japan		
Ryukyu Islands	26°N	128°E
Fugi, Honshu	35°N	139°E
East Indies		
Krakatoa, Indonesia	6°S	105°E
Papua, New Guinea	3°S	144°E
Canlaon, Philippines	10°N	123°E
Mayon, Philippines	13°N	124°E
Central Pacific		
Mauna Loa (Hawaii)	19°N	156°W
Mariana Islands	18°N	145°E
Galapagos Islands	1°S	91°W
South Pacific		
North Island, New Zealand	38°S	176°E
Tahiti	18°S	149°W
American Samoa	13°S	172°W

Hitting the hot spots - Activity 1 - Ring of Fire



(Images taken from:

http://www.wilsoncreek.org/Staff/vclinton/Asia%20Website/Question_1.htm)

Summary of Classoom Activities Listed:

Egg/Earth's layers demo (teacher led), ,
Coloring of Geological time scale,
Completing a Pangean puzzle,
Tectonic plate demo (student led),
Identifying Ring of Fire (longitude & latitude practice), etc (just to name a few)

Lectures: Early Earth (middle) & Early Earth (high school)… please see accompanying power point notes.

Works Cited:

- **Website (Student handout Ring-of-fire) :**
- **http://www.nps.gov/mora/learn/education/upload/mapping-the-ring-of-fire_student-handout.pdf**
  Website Title: National Parks Service
  Article Title: National Park Service
  Publisher: U.S. Department of the Interior
  Electronically Published: February 22, 2016
  Date Accessed: February 2, 2016
  Author: United States. National Park Service

- **Website (Interior earth powerpoint):**
  http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=0ahUKEwjahb7Z2Y7LAhVD9R4KHUWyCOIQFggpMAQ&url=http%3A%2F%2Fschool.judsonisd.org%2Fwebpages%2Fdhess%2Ffiles%2Finside%2520the%2520earth%2520(2).ppt&usg=AFQjCNHdC4HCk1uU8EztnLtDWIZaTurvAA&sig2=sR-cCZEpBQRveh-j-o19Gw&bvm=bv.114733917,d.dmo

Reading List, Teacher and Student Resources:

- **Earth as an egg video/demo:**

  http://www.iris.edu/hq/inclass/video/earth_vs_the_egg_measuring_earths_layers

- **Early earth evolution template:** : http://darwiniana.org/geology.htm

- **Pangea template:** http://www.rocksinmyheadtoo.com/Pangea.htm

- **Land mass movements (early earth):**

  https://www.pinterest.com/pin/73042825182955075/activity

- **Cookie Earth boundaries:**

  https://www.pinterest.com/pin/277604764501724992/

- **Ring of Fire Practice:** :

  http://www.wilsoncreek.org/Staff/vclinton/Asia%20Website/Question_1.htm

Appendix 1: Example of Additional Read & Respond Activities (homework):

Earth In the Beginning

By Tim Appenzeller *National Geographic*

The early Earth was a vision of hell, all scalding rock and choking fumes. Since then, its surface has cooled, continents have drifted, mountains have risen and eroded, and life has emerged. Nearly all traces of the planet as it was have been wiped away. But from clues in the oldest rocks, deepest magmas, and even the cratered face of the moon, scientists have traced the planet's beginnings.

Its birth began some 4.5 billion years ago as rock and ice particles swirling around our young sun collided and merged, growing into planets. In violent collisions, they smashed together to create planets, including the baby Earth. In the turmoil, another object, as big as Mars, struck our planet. Most of the object was swallowed up in the bottomless magma ocean it created. But the collision also flung a small amount of rock into orbit. This debris quickly gathered itself into a ball, creating our moon.

After the moon's birth, the Earth's surface cooled. Even so, our planet remained an alien world for the next 700 million years; scientists call this time the Hadean, after the Greek underworld (or, hell). Rafts of solid rock drifted in the magma. Gases hissed from the cooling rock—carbon dioxide, nitrogen, water vapor, and others—covering the planet in a poisonous atmosphere. As the temperature dropped, clouds began to form and rain fell, cooling the surface into rock. Some of the water pooled into bodies of water.

By 3.8 billion years ago the Earth stopped being impacted by asteroids. Oceans became deeper. About that time, perhaps in the oceans, single-celled, blue-green bacteria flourished in the sunlight. By the trillions, these microscopic organisms transformed the planet. They captured the energy of the sun to make food, releasing oxygen as a waste product. Little by little they turned the poison atmosphere into breathable air, opening the way to the diversity of life that followed.

Those days are long gone, but the processes that turned our planet from a hell to a habitable world still exist today. Heat left over from the planet's formation still bursts out in volcanic eruptions, spilling lava like the young, cooling Earth. In the planet's harshest environments today, the same bacteria live as they have for billions of years.

Note: Students will already have a background in photosynthetic processes to complete this section.

1. We learned about gravity in our first unit: Earth in Space. In what line is gravity referenced in this reading? Use your own words to describe how gravity played a part in creating the planet Earth.

_____

_____

2. Put the following events in order. Use 1 for the earlier and 6 for the most recent event.

____The surface was hot and fiery, with volcanic eruptions

____Pieces of rock collided to make a planet

____The first form of life developed in the oceans

____The atmosphere was no longer poisonous

____The moon was created

____Rain fell

3. What was the first form of life? Why was it important?

_____

_____

Appendix 2: PA Standards:

Standard - 3.3.6.A4

1. *Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.*
2.

Standard - 3.3.6.A6

MODELS/SCALES
Describe the scales involved in characterizing Earth and its atmosphere.
MODELS/SCALES
Create models of Earth's common physical features.

Standard - 3.3.6.A7

1. *Understand how theories are developed.*
2. *Identify questions that can be answered through scientific investigations and evaluate the appropriateness of questions.*
3. *Design and conduct a scientific investigation and understand that current scientific knowledge guides scientific investigations.*
4. *Describe relationships using inference and prediction.*
5. *Use appropriate tools and technologies to gather, analyze, and interpret data and understand that it enhances accuracy and allows scientists to analyze and quantify results of investigations.*
6. *Develop descriptions, explanations, and models using evidence and understand that these emphasize evidence, have logically consistent arguments, and are based on scientific principles, models, and theories.*
7. *Analyze alternative explanations and understanding that science advances through legitimate skepticism.*
8. *Use mathematics in all aspects of scientific inquiry.*
9. *Understand that scientific investigations may result in new ideas for study, new methods, or procedures for an investigation or new technologies to improve data collection.*
10.

Standard - 3.3.7.A1

1. *Define basic features of the rock cycle.*
2. *Describe the layers of the earth.*
3. *Differentiate among the mechanisms by which heat is transferred through the Earth's system.*

4.

Standard - 3.3.7.A3

1. *Explain and give examples of how physical evidence, such as fossils and surface features of glaciation support theories that the Earth has evolved over geologic time.*
2. *Compare geologic processes over time.*

Standard - 3.3.8.A3

1. *Explain how matter on earth is conserved throughout the geological processes over time.*

Standard - 3.3.8.A1

1. *Distinguish between physical and chemical weathering.*
2. *Compare and contrast the types of energy that drive Earth's systems.*

Standard - 4.1.8.B

1. *Relate plate tectonics to both slow and rapid changes in the earth's surface. Describe the rock cycle and the processes that are responsible for the formation of igneous, sedimentary, and metamorphic rocks. Relate geochemical cycles to the conservation of matter. Explain how the Earth is composed of a number of dynamic, interacting systems exchanging energy or matter.*

Appendix 3
Early Earth (middle) & Early Earth (high school)