B Lin Earth Science

Unit: Plate Tectonics

Stage 1 – Desired Results

Established Goals:

Content Standard: Unifying Concepts and Processes: As a result of activities in grades k-12, all students should develop understanding and abilities aligned with the following concepts and processes: Evidence, models, and explanation.

Content Standard A: Science as Inquiry: As a result of activities in grades 9-12, all students should develop abilities necessary to do scientific inquiry: Identify questions and concepts that guide scientific investigations; Formulate and revise scientific explanations and models using logic and evidence; Communicate and defend a scientific argument.

Content Standard D: Earth and Space Science: As a result of their activities in grades 9-12, all students should develop an understanding of … Energy in the earth system; Origin and evolution of the earth system.

Content Standard E: Science and Technology: As a result of their activities in grades 9-12, all students should develop … Understandings about science and technology: Scientists in different disciplines ask different questions, use different methods of investigation and accept different evidence

Content Standard F: Science in Personal and Social Perspectives: As a result of their activities in grades 9-12, all students should develop understandings of … Natural and human-induced hazards: Some hazards (earthquakes, volcanoes, severe weather) are rapid.

Understandings:	**Essential Questions:**
Students will understand that … Convection currents in the mantle move energy among the layers of the earth Motions of tectonic plates cause most earthquakes and volcanoes Models explain processes changing earth's crust	**What causes volcanoes and earthquakes?** **Can you predict volcanic eruptions and earthquakes?**
Students will know … *The historical developments in understanding that has led to our current understanding of plate tectonics* *Patterns of tectonic plate boundary behaviors*	*Students will be able to …* *Identify locations that have a high chance of earthquakes & volcano eruptions* *Use earthquake & volcano location data to identify tectonic plate boundaries* *Use earthquake & volcano data to identify types of tectonic boundaries* *Use GIS software (This Dynamic Planet)* *Support explanations and models with evidence* *Identify origin of and earthquake using seismic data*

Stage 2 – Assessment Evidence

Performance Tasks:	**Other Evidence:**
Group Tectonic plate identification – students will identify the tectonic plate a specific structure sits on using earthquake and volcano data Boundary behaviors – students will identify the behavior of their plate and neighboring plates at the boundaries of their plate using earthquake and volcanic data Plate Tectonic Justification Document - ID earthquake origin and magnitude using seismic data	Written test – questions probing student understanding of convection currents, models of the earth's interior structure, historical development of theory of plate tectonics; use of seismic data to locate epicenter of earthquake

B Lin Earth Science

Stage 3 – Learning Plan
1) Knowledge 2) Comprehension 3) Application 4) Analysis 5) Synthesis 6) Evaluation
Learning Activities: 1. Re-aloud from *Surviving Galeras* – 1 2. Historical Articles – 1, 6 3. Expanding Earth Discussion – 1, 4, 5, 6 4. Earth structure intro articles – 1, 2 5. 3D maps – 2, 3, 4 6. Earthquake packet – 1, 2, 3 7. Mid-unit Quiz – 1, 2, 3, 6 8. Video – Rivers of Fire (New Explorers) 1, 2 9. Hot Spots – 2, 3, 4 10. Earthquake & Volcano data analysis This Dynamic Planet – 1, 2, 3, 4 11. *Milky Way Plate Tectonics* Volcano & Earthquake data patterns – 1, 2, 3 12. Large Map Documentation – 2, 3, 4 13. Plate Tectonic Justification Document - 1, 2, 3, 4, 5, 6 14. Lake Nyos Volcano – 1, 2, 3, 4 15. Written test – 1, 2, 3, 4, 5, 6

1. **Video – Re-aloud from *Surviving Galeras* – 1**
Objective: Plate Tectonics Introduction
Activity: 1. Read sections of the book *Surviving Galeras*. This story recounts a volcanologist's experience on a hike on a volcano when it erupts.
2. Orange Earth – show an orange to class; ask them to describe the earth's structure – how is it like an orange? The crust is thin like the orange's skin. The inside of orange is not a good model of earth's interior.
Materials: *Surviving Galaeras;* orange
Big Idea: Earthquakes/Volcanoes exhibit a lot of power. They are unpredictable, hazardous

2. Historical Articles – 1,6
Objective: Historical contributions to the development of tectonic theory
Activity: 1. Students, in small groups will read variety of articles following development of theory;
2. Whole class talk, using timeline, of the theory's development, major discoveries & ideas
Materials: articles
Big Idea: Continental drift (Alfred Wegner); convection currents power continental drift (Arthur Holmes); Great global rift found in ocean (Germany, Maurice Ewing & Bruce Heezen); Sea-floor spreading (Harry Hess); Magnetic field flips (Fred Vine & Drummond Matthews)

3. **Expanding Earth Discussion – 1, 5, 6**
Objective: Understand how to distinguish "good science" from "bad science"
Activity: 1. Present expanding earth video to students, have them talk about it in their table groups for ~3 min, and then discuss as a class why it doesn't make sense.
2. Compare/contrast points brought up by "expanding earth" and tectonic theory. Why is one "good science" and the other not?
3. (Optional) Show video of someone's response to the expanding earth theory.
Materials: YouTube video
Big Idea: Some "theories" by people are not truly scientific and it's important to recognize what makes "good science"

B Lin Earth Science

4. Earth structure intro articles – 1
Objective: Earth structure intro – plate tectonics
Activity: 1. Assign student groups earth structures – students read articles, answer intro questions about their particular structure and identify on world map where structure is located; 2. Students share with whole class about their structure – where it is, what it is, interesting fact
Materials: list of structures with student assignments; articles; maps – both individual topo maps and world map for each student; large class map one for each period
Big Idea: Reading of topo map; Location of structure on world map (using latitude & longitude)

5. 3D maps – 2, 3
Objective: Earth structures – plate tectonics; Using topo maps
Activity: 1. Intro to 3D map using Mt Barge topo map and craft form map
2. Students will make 3D structure for large map – students will use topographical map to make 3D rectangle for large map of their structure.
3. Students will use info from structure article to make "flag" for large map
4. Students will place their 3D map on large class map
Materials: Individual structure topo map; Craft form; glue; exacto knives; scissors; Mt Barge demo 3D map; index cards for flag; Large class map (one for each class)
Big Idea: Reading topo map; 3 dimension image of earth structure; using latitude & longitude for location identification

6. Earthquake packet – 1, 2, 3
Objective: Earthquakes
Activity: 1. Whole class discussion (powerpoint) of seismic waves using slinky & video clips;
2. Discussion (powerpoint) of how earthquakes are used to determine Earth's interior
3. Discussion (powerpoint) of how epicenter is located using seismic data
4. Virtual Earthquake – Online seismic data analysis
5. Students will work in teams on packet about earthquakes – their cause, their use for interior studies of the earth
Materials: Powerpoint notes; slinky; seismic wave video clips; Earthquake Packets for each student; computers with internet
Big Idea: P waves; S waves; surface waves; Locating epicenter of earthquakes.

7. Mid-unit Quiz – 1, 2, 3, 6
Objective: Assess what students have learned from the unit thus far.
Activity: Individual, paper assessment that asks students to read topographic maps, explain how tectonic theory was justified, and how the expanding earth theory is not "good science."
Materials: Quiz
Big Idea: Assessment

8. Video – Rivers of Fire (New Explorers) – 1, 2
Objective: Volcanic eruption cause & prediction
Activity: 1. Whole class viewing of *New Explorers* video *Rivers of Fire* highlighting earthquake prediction research
Materials: video *New Explorers Rivers of Fire*
Big Idea: Causes of volcanic eruptions; Ability to predict eruptions is developing; Job of volcanologist

9. Hot Spots – 2, 3
Objective: Volcanic Hot spots

B Lin Earth Science
Activity: Students measure movement of Hawaii over hot spot, rate and direction
Materials: 1. Discussion of Hawaii and its location relative to tectonic plates – in center of plate not at edges
2. Group work measuring rate of movement and direction of Hawaii over hot spot
Materials: demo of hot spot – paper and pencil; hot spot packet; rulers
Big Idea: Hot spots form volcanoes away from plate boundaries; Hot spots are jets of super hot magma rising to earth's surface

10. Earthquake & Volcano data analysis This Dynamic Planet – 1, 2, 3
Activity: 1. Introduction to This Dynamic Planet webpage – show whole group how to use it;
2. Students experiment with webpage (intro to using it)
3. Students will identify location of their using This Dynamic Planet;
4. Students groups (Earth Structures on same plate) will determine and draw plate on their world map;
Materials: computers with internet access; individual world map
Big Idea: Location data on earthquakes and volcanoes can identify tectonic plates

11. *Milky Way Plate Tectonics* Volcano & Earthquake data patterns – 1, 2, 3
Objective: Volcano & Earthquake data patterns
Activity: 1. Whole class discussion & identification of data patterns and their relationship to plate movement using *Milky Way Plate Tectonics* and This Dynamic Planet website – students use a snack size milky way to model plate behavior at plate boundaries; patterns of earthquake and volcano data are identified for each type of plate boundary behavior (subducting, buckling, rifting and transform)
2. Students will identify location of their plate & movement of plate of their plate using the behavior at boundaries based on GIS data
3. Students will identify these movements on their individual world maps
Materials: Milky Way candy bars snack size for each student; plastic knives one/table; paper towels; handout; powerpoint; computers with internet access; individual world maps
Big Idea: Patterns in earthquake and volcano location data (GIS) identify how plates are interacting with their neighboring plates

12. Large Map Documentation – 2, 3
Objective: 1. Group identification of plates
Activities: 1. Mini conference – group students with other groups that have structures on the same tectonic plate. They should agree on location of plate, direction of movement of plate, any hot spots on plate and behavior at boundaries
2. Student groups will draw their plate on large map and identify boundary behaviors on map
Materials: Large map; pencils, markers
Big Idea: Patterns in earthquake and volcano location data (GIS) identify how plates are interacting with their neighboring plates

13. Plate Tectonic Justification Document – 1, 2, 3, 4, 6
Objective: Individual justification of plate location, behavior and movement direction; Assessment
Activity: 1. Introduce document activity. Go over evidence needed in document.
2. Individual students will create a document that describes their plate, the interaction of their plate with its neighboring plates and the overall direction of motion of their plate with Dynamic Planet data evidence. The document must include: location of earth structure on earth clearly identified; description of the land and water the plate carries; description of how plate interacts with all of its neighboring plates; overall direction of plate is clear; pictures from This Dynamic Planet showing evidence; writing clearly connects to evidence pictures (look at rubric)
Materials: Document description (???); Rubric; computers with internet access

B Lin Earth Science
Big Idea: Patterns in earthquake and volcano location data (GIS) identify plates and how plates are interacting with their neighboring plates

14. Lake Nyos Volcano – 1, 2, 3, 4
Objective: Volcanoes – Lake Nyos
Activity: 1. Read article together as class establishing what happened.
2. Student groups run simulation of Lake Nyos disaster;
Materials: articles; lab materials from Lake Nyos kit
Big Idea: Gas outflows from volcanoes are deadly. They can build up unseen but can be detected

15. Written Test – 1, 2, 3, 5, 6
Objective: Assessment
Activity: Questions probing student understanding of convection currents, models of the earth's interior structure, historical development of theory of plate tectonics; use of seismic data to locate epicenter of earthquake
Materials: test
Big Idea: Assessment