Title:	Plate Tectonics/Magnetic Reversals Activity	
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Course **Grade:**	Earth Science, Integrated Physical Science, World Geography, Arkansas History, Economics, US History since 1890, Language Arts 9-12	**Duration:** One 45-minute class

Objective:
Students will model changes in the Earth's surface and the age of Earth's surface in relation to convergent and divergent boundaries and will learn how this relates to careers in petroleum exploration.

Summary of Lesson:
Students will use bulletin board paper to model the crust of the earth as it is produced at divergent boundaries and subducted at convergent boundaries. The age of crustal material is demonstrated with the paper strips as it is "created" or "destroyed". After creating these models, students will research careers that use this information to explore for petroleum and will develop a visual describing one of the careers.

Arkansas Standards:

CODE	GRADE	SLE	STANDARD
EARTH SCIENCE	**9-12**	**ES-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.
		ES-ESS2-1	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
		ES-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources occurrence of natural hazards, and changes in climate have influenced human activity
		ES-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios

		ES-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
INTEGRATED PHYSICAL SCIENCE	**9-12**	**PSI-ESS2-1**	Develop a model to illustrate how Earth's internal and surface processes operate at different spacial and temporal scales to form continental and ocean-floor features.
WORLD GEOGRAPHY	**9-12**	**PR.3.G.3**	Analyze the impact of cultural and social factors on individuals' varying perceptions of places and regions created by physical characteristics and human influences
		HS.4.G.2	Analyze the effects of various influences on population distribution (e.g. history, migration, physical environment, economy, politics, technology, climate, land use, resources)
		ES.7.G.1	Analyze effects of changes made by humans on the physical environment (e.g. industrialization, agricultural, rural land use, urban land use, mining, forestry)
ARKANSAS HISTORY	**9-12**	**ERA4.4H.9-12.2**	Analyze economic developments in Arkansas during the early 20th century (e.g., Monte Ne and Hot Springs resorts, oil boom, timber industry)
ECONOMICS	**9-12**	**EM.2.E.2**	Demonstrate changes in supply and demand (e.g., shifts, shortages, surpluses, availability) that influence equilibrium price and quantity using a supply and demand model
US HISTORY SINCE 1890	**9-12**	**ERA7.2.USH.1**	Analyze the relationship between industrialization and immigration/migration in the US
		ERA7.2.USH.2	Investigate the impact of the Progressive Ear using a variety of sources and multiple perspectives
		ERA8.3.USH.2	Analyze the federal government fiscal responses to the Great Depression (e.g., Tennessee Valley Authority, social security, minimum wage, construction projects)
LANGUAGE ARTS	**9-12**	**W.9-10.2 W.11-12.2**	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

		W.9-10.2.A **W.11-12.2.A**	Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include appropriate text features (e.g., captions, headings), graphics (e.g., figures, tables), and/or multimedia.

Teacher Excellence Support System (TESS):
Domain 1b: Teacher Knowledge of students. (learning types)
Domain 1d: Demonstrating knowledge of resources. (use what is available)
Domain 2e: Organizing physical space.
Domain 3c: Engaging students in learning. (get them involved)

Instructional Strategies and Practices:
Marzano, cooperative learning and nonlinguistic representations.

Bloom's Level: Highest Level Only
Applying

Materials and Resources:

- Long strips of bulletin board paper (8-10 feet long), 1 per group.
- Markers
- Classroom tables
- Art supplies for creating visuals
- Computers for creating visuals
- Student Handout 1: Plate Tectonics Observation Sheet
- Student Handout 2: Plate Tectonics -- Career Exploration

Formative Assessment:
Paper strips turned in, lab report, student visuals display in and near classroom.

Notes to Teacher:
The activity models the movement of the Earth's tectonic plates and plate boundaries. This is a very good activity for visual and kinesthetic learners and an excellent opportunity to introduce students to careers in petroleum exploration and production.

Student:

1. Use one of the websites listed below or local resources to develop a brief presentation to introduce plate tectonics and give students background information.

(These websites may change over time. If a website is no longer available, search the internet for resources on plate tectonics.)

Plate tectonics

http://www.aapg.org/about/petroleum-geology/geology-and-petroleum/plate-tectonics
http://geology.com/teacher/plate-tectonics.shtml

2. Divide students in to working groups.

3. Distribute **Student Handout 1: Plate Tectonics Observation Sheet** for **each student**.

4. For the activity, arrange 2 classroom tables end to end so there is gap that is approximately 1/2" between them.

5. Distribute long strips of bulletin board paper (8-10 feet long) to each group. Students will fold paper in half crosswise so that they have 1 piece 4-5 feet long.

6. The fold is fed down between the seam where two classroom tables meet until only an inch or so is exposed. This is the divergent plate boundary.

7. Students gently pull on the two exposed ends of the paper in opposite directions. Gradually pulling away from the seam where the tables meet.

8. Every inch, the students draw a line on the paper on opposite sides of the table seam, and number the newly exposed segment on both sides of the "divergent plate boundary". Each new line is numbered successively higher.

9. Students should notice that the numbers are equal on both sides, with the lowest being the farthest from the plate boundary, and highest number nearest the plate boundary, hence the "oldest crust" and "youngest crust" of the earth.

10. Students perform the same experiment, but in reverse, and observe how the paper is taken in and destroyed by the "convergent plate boundary" as it is pulled into the crack between the two tables, thus destroying the earth's crust as it is drawn into the mantle below.

11. Students record their observations on the student observation sheet. (See **Student Handout 1**). Volunteers share their observations.

12. Use the following to SUMMARIZE the lab:

"Earth's plates move at incredibly slow rates when viewed with human lifespan as a comparison standard. But when viewed in comparison to the age of the earth, these plates move incredibly fast. This activity allows us to see on a small scale how those plates add new material to the areas where they are pulling apart from each other. In addition, it allows us to see how the current crustal material is pulled down into the interior of the earth, melted, and recycled.

Depending on how these plates move over time, they create geologic events such as volcanoes and earthquakes and can form mountain ranges. This movement of the Earth's surface impacts where oil and natural gas deposits can be found (1)

Petroleum geologists and petroleum engineers can use this information to help determine where to explore for oil and natural gas deposits. These two fields are among the highest paid workers in the petroleum industry."

12. Students will use library and internet resources to explore careers in petroleum engineering and petroleum geology. They will create a visual on one of the careers using **Student Handout 2: Plate Tectonics -- Career Exploration** as a guide to compile information. The following websites may be used to help students begin their search for career information.

(These web sites may change over time. If a web site is no longer available, explore the internet for careers in oil and gas industry.)

Careers in petroleum exploration and production

https://www.api.org/about/industry-careers
https://www.acs.org/content/acs/en/careers/college-to-career/chemistry-careers/oil-petroleum.html

13. Student's work will be displayed in the classroom and in the area near the classroom as space allows.

14. The teacher will develop a rubric for grading the visual.

References Cited:

1. American Association of Petroleum Geologists website: http://www.aapg.org/about/petroleum-geology/geology-and-petroleum/plate-tectonics

Student Handouts: See website for printable copy at https://arkansasenergyrocks.com/educators/lesson-plans-9-12

Student Handout 1
Plate Tectonics
Observation Sheet

Name of Observer _____ Class Period_____ Date _____

I observed:

An illustration of what I observed:

What I learned from this observation:

Student Handout 2
Plate Tectonics
Career Exploration

Use the following outline to research petroleum engineer and petroleum geologist. Your research will be turned in.

Once you have completed your research choose one career and create a visual that promotes your chosen career. The visual can be created on half of a poster board (22 x 14) using markers, colored pencils or collage materials. Illustrations can be taken from magazines or can be printed from the internet. The visual may also be created on the computer with design software. If a computer is used, it must be printed on 8 ½ x 14-inch paper.

Your visual will be displayed in or near the classroom. Be sure your name is on the back of your work.

The visual must include the following information:

- Job Description – describe the day-to-day duties and tasks that are required, include equipment and technology that will be used on the job.
- Working conditions – describe the typical setting for this career.
- Educational Requirements – describe the course of study required to prepare for an entry level job; include the high school subjects that would be helpful in preparing for this occupation. If additional training is needed to advance in the field, identify the type and duration.
- Salary – include entry level and advanced.
- Availability of jobs – describe the future outlook for job openings in this field.