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## Theory of Plate Tectonics

**Grade Level:** Middle and High School

**Purpose:** Theories concerning the development of landforms and the causes of geologic occurrences have developed through time. Individual ideas combined to result in the modern Theory of Plate Tectonics. Students will create their own super continents by fitting modern continents together according to shape and similarities among plants and animals. Students will have an understanding of how the Theory of Plate Tectonics relates to Nevada's Great Basin region.

**Objective:** The student will be able to use available theory information to construct a super continent with paper cutouts. The student will be able to use resource materials to write an essay relating the Theory of Plate Tectonics to the Great Basin region.

### Nevada State Standards:

- **Life Science Content Standard 9.0: Evolution – The Process of Biological Change—**Students understand that life forms change over time.
- **Earth and Space Sciences Content Standard 10.0: Earth Structures and Composition—**Students understand that the Earth is composed of interrelated systems of rocks, water, air, and life.
- **Earth and Space Sciences Content Standard 11.0: Earth Models—**Students understand that the Earth may be represented by a variety of maps and models.
- **Earth and Space Sciences Content Standard 12.0: Earth History—**Students understand that Earth systems (such as weather and mountain formation) change or vary.

### Materials:

- Puzzle pieces (world map, preferably blank, copied onto cardstock), one per group of students
- Map of the world or globe
- Scissors, pencils, pens, glue, construction paper





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Map of Pangaea  
“History of Plate Tectonics”

**Anticipatory Set:** Begin lesson by sharing the following information with your students: The Great Basin region (about 160,000 square miles that encompasses most of Nevada and parts of California, Idaho, Oregon, and Utah that is bounded by the Sierra Nevada Mountains on the west and the Wasatch Range on the east) began forming some 3 billion years ago and is still changing today. Author Frank L. DeCourten states in The Broken Land: Adventures in Great Basin Geology that, “The crust of the [Great Basin] region has been so thinned, weakened, and stretched that it appears ready to pull apart completely in the geological future. No matter how ageless and enduring the Great Basin seems, we are undoubtedly on the threshold of a new landscape.” (Page 243). Ask students what they think this statement means. How could the Great Basin region be about “ready to pull apart completely”? What does the author mean by the term geologic future? What do you think a new landscape would look like? Discuss these questions and any other that might arise as a class.

Tell students that the Earth is a dynamic and constantly changing planet. Ask students to name the fault line in California infamous for its earthquakes. What causes these earthquakes to occur? Explain to students that on the outer layer of the Earth’s surface are thin, fragile plates that move very slowly on the Earth mantle’s upper layer. This movement is caused when the Earth releases its internal heat by convecting, or boiling much like a pot of pudding on the stove. As the Earth’s hot mantle rises to the surface, it spreads laterally and transports oceans and continents on a slow conveyor belt. The speed of this motion is very slow, only a few centimeters a year. These sliding plates are constantly in motion. When they collide or separate, the result can be earthquakes, mountain building, volcanism, production of new crust and the destruction of old crust. The movement of the plates also causes continents to move and is responsible for the present day location of the continents. The Great Basin region itself is very clear evidence of the rifting process by which continents are formed and reformed.

Tell students that they will be doing an activity in class to learn more about the theory of how the Earth’s plates have been moving over time, also known as the Theory of Plate Tectonics, to see how it relates to the Great Basin region.

**Developing the Lesson:** Show students a map of the world. Have students name each of the continents and locate them relative to one another. Make photocopies of a blank map of the world onto cardstock paper, one for each student or team of students. Have the students write the name of the continents on each puzzle piece. Cut out the drawings so that there are now seven puzzle pieces, each as one continent. Group students in small teams and pass out the “History of Plate Tectonics” to be read together. Tell students to use the available information to experiment with putting the pieces together so that they all fit like a puzzle (there are no right or wrong answers to how the continents fit together). Have the students experiment with the pieces and glue them onto a piece of construction paper when the entire group has decided on a final position; they must be able to back their choice by facts from the article.

Have each team of students explain on paper why they thought each continent fit best where they placed it.





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### Developing the Lesson (continued):

Have the students experiment with the pieces and glue them onto a piece of construction paper when the entire group has decided on a final position; they must be able to back their choice by facts from the article. Have each team of students explain on paper why they thought each continent fit best where they placed it.

Show students a copy of the accepted version of Pangaea and discuss why the students' versions might have ended up differently from the one that scientists accept.

### Discussion questions for groups:

1. Did your puzzle change shape when you thought about how the plants, animals, and fossils also fit together? Why or why not?
2. Did everybody's puzzle look the same when you were finished putting it together? Why do you think this happened?
3. Did all of your plant and animal evidence match up? What about Australia, why are all the animals there so weird? (*Teacher's note: Australia separated from the other continents first, so its animals had more time to adapt to their surroundings independent of outside influences.*)
4. What caused the continents to move in the first place? Are they still moving? What is moving them today?

**Closure:** As a class, discuss the groups' answers to the discussion questions and review the history/basic principles of Plate Tectonics. Put the following question on the board or overhead: How is the Great Basin region evidence for the Theory of Plate Tectonics? Discuss students' ideas and list their responses on the board. Have students research the geological history of the region on the internet or by using resource materials to write a short essay answering this question. The following resources can be used for this research:

- [The Broken Land: Adventures in Great Basin Geology](#) by Frank L. DeCourten
- [Geology of the Great Basin](#) by Bill Fiero
- [Great Basin, the Story Behind the Scenery](#) by Michael Nicklas
- [Hiking the Great Basin: The High Desert Country of California, Nevada and Utah](#) (Sierra Club Tote book, see the introduction) by John Hart

The Nevada section of your local library is another great place to look.





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**Evaluation:** Formally assess students by their answers to the group questions and by the quality of their research/essay. Informally assess students by their ability to contribute meaningfully to the group effort and by their contributions to the class discussion.

**Teacher's Note:** Nevada has a complex plate-tectonic environment, dominated by a combination of extensional and transform motions. The Great Basin shares some features with the great Tibetan and Anatolian plateaus. All three have large areas of high elevation, and show varying amounts of rifting and extension distributed across the regions. This is unlike oceanic spreading centers, where rifting is concentrated narrowly along the plate boundary. The numerous north-south mountain ranges that dominate the landscape from Reno to Salt Lake City are the consequence of substantial east-west extension, in which the total extension may be as much as a factor of two over the past 20 million years.



(Topo map from the [Lamont-Doherty Earth Observatory](#) of Columbia Univ.; motions added from published GPS results.)

The extension seems to be most active at the eastern and western margins of the region, i.e. the mountain fronts running near Salt Lake City and Reno. The western Great Basin also has a significant component of shearing motion superimposed on this rifting. This is part of the Pacific - North America plate motion. The total motion is about 5 cm/year. Of this, about 4 cm/yr takes place on the San Andreas fault system near the California coast, and the remainder, about 1 cm/year, occurs east of the Sierra Nevada mountains, in a zone geologists know as the Walker Lane. As a result, Nevada hosts hundreds of active extensional faults, and several significant transform fault zones as well. While not as actively or rapidly deforming as the plate boundary in California, Nevada has earthquakes over much larger areas. While some regions in California, such as the western Sierra Nevada, appear to be isolated from earthquake activity, earthquakes have occurred everywhere in Nevada. orientations for each continent, the continents moved and the poles stayed in their relative locations.



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# Plate Tectonics Lesson Plan

In 1962 Harry Hess proposed the theory of seafloor spreading. He used information gathered from seafloor basalt studies along the Mid-Atlantic spreading ridge. He suggested that the continents did not float about, but interacted with oceanic crust. Plate interactions formed mountain ranges, earthquakes, and volcanoes. He also proposed a mechanism for driving the movement of plates. This mechanism is known as convection cells. Some of the continents fit together as though they were part of a continental puzzle. More importantly, much of the fossil, plant, and animal life seemed to match where the puzzle pieces fit together.

Plate tectonics is a combination of two ideas: continental drift and sea-floor spreading. The theory has unified the study of the Earth by drawing together many branches of the earth sciences, from paleontology (the study of fossils) to seismology (the study of earthquakes). It has provided explanations to questions that scientists had speculated upon for centuries—such as why earthquakes and volcanic eruptions occur in very specific areas around the world, and how and why great mountain ranges like the Alps and the Himalayas formed. In short, plate tectonics has revolutionized the way geologists think about the Earth