Plate Tectonics

Level: High School
Facilitator Guide

LESSON DETAILS

Objective: Students will investigate the tectonic processes that formed the Nevada landscape, relating these processes to how mineral deposits have formed throughout the state.

Standards

NVACSS and NGSS

- **HS-ESS3-5:** 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-ESS1-6:** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation in early history.
- **HS-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.
- **DCI:** The History of Planet Earth; Plate Tectonics and Large-Scale System Interactions;
- **SEP:** Analyzing and Interpreting Data; Constructing Explanations and Designing Solutions
- **CCC:** Cause and Effect; Patterns

Career Readiness

- **1.2.6:** Demonstrate lifelong-learning skills by continually acquiring new industry-related information and improving professional skills.

Materials

- computer with internet access

Lesson Summary

Students begin by looking at maps of mineral deposits around the U.S. and Nevada to look at patterns of mineral locations in relation to geologic formations. They will then use an interactive to describe how the land now designated as Nevada has changed throughout Earth's history due to tectonic plate movement. Students then learn about specific tectonic processes that have shaped the Nevada landscape. Students then investigate how lithium deposits formed in Nevada. The lesson concludes with students researching other minerals and how they formed in relation to tectonic processes.

Preparation

Before **Explain**, you may want to review these resources which provide background: **Geology of Nevada**, **The Basin and Range Province.**

Engage

1. Have students explore a **map of mineral deposits** in the U.S. that are of interest to many industries, particularly renewable energies.

    a. Students should make observations of patterns in mineral locations.

    b. As you discuss students' observations, focus on lithium and tungsten, as they are most commonly associated with high mountains. They should also turn on the "geologic units" layer to note that these minerals are associated with igneous rocks.

    c. Students should then zoom in on Nevada to make observations of mineral deposits in addition to patterns in landforms (parallel lines of mountains).

2. Discuss students' observations and their ideas about how Nevada's mountain chains have a unique pattern not seen in any other states.

Explore

1. Review with students what they have learned about plate tectonics.

2. Have students access **HHMI's EarthViewer** interactive to see how tectonic plate movement has affected continental masses over Earth's history. A tutorial should pop up when the interactive is opened which will show students how to use specific features within it.

    a. Be sure that the "Cities" and "Grid" are turned on in the "View" menu at the bottom middle of the screen.

    b. Students may also want to turn on "Coastlines" as a reference for where the U.S. is currently located.

    c. Have students move the map to center Nevada on the screen.

    d. In the Paleo Earth layer on the left of the screen, have students move the silver bar to scroll back to the beginning of the Carboniferous Period. They may want to do this slowly so they can keep track of where Nevada is (the interactive maintains the state borders as best it can for reference, keeping in mind that changes in landforms will alter the shape of the states as they currently exist).

    e. Have students slowly move through time to the present, summarizing major events that would have affected the rocks, minerals, and sediment in Nevada.

Explain

1. Discuss the major events that students studied in the interactive that led to Nevada's current landscape, focusing on mountain-building events.

2. Play the video "**Plate Tectonics and California Geology**" up to time 3:05. The geologic events described also helped shape the landscape of states north and east of California, including Nevada.

3. Project **HHMI's EarthViewer interactive** for students to view as a class.

   a. Center Nevada on the Earth, then scroll back to the beginning of the Paleogene Period.

   b. Slowly scroll to present time. Have students make observations of how Nevada has changed over the past 66 million years, namely that it is getting wider.

   c. Have some students share suggestions of why or how the land is spreading out.

4. Allow students time to study a **map of Nevada faults** and give them time to share their observations (e.g., patterns in the faults, differences in sizes, their direction).

5. Show students a **cross-section of an area of Nevada** that has a number of these faults.

   a. You may want to start by looking at the geologic map and what it depicts. The colorful areas (the colors indicate igneous and metamorphic rocks) are mountains, and the tan/yellow (which indicate sedimentary rocks) regions are the basins between them.

   b. Show students the two lines (A-->A' and B--> B') that indicate where cross-sections have been drawn.

   c. Scroll down and show them the cross sections, allowing time to make observations or ask questions (which may or may not be answered at this time).

6. **Set up a model** (or show a **video of a model**) to show how a basin and range landscape forms. Discuss the layers of the model with the students being different colors, much like the geologic map.

7. Return to the video "**Plate Tectonics and California Geology**" and show it from 3:18-5:42 (noting that the last location talked about, Panum Crater, is in California, very close to the Nevada border).

8. Discuss how the tectonic setting of Nevada has led to it being ranked as the number one state for mineral extraction. Discuss what types of minerals students might expect to find in different areas of Nevada given the tectonic settings.

   a. Speak generally about where students expect to find minerals that formed by igneous or metamorphic processes, versus those deposited by sedimentary processes.

   b. If you have covered specific minerals, you may want to reference examples.

Elaborate

1. Have students view an image showing how lithium deposits form (the images below are listed in order of decreasing complexity, depending on how detailed you want to cover the process of lithium deposition). Discuss the process, relating it to both igneous and sedimentary activity.

    a. **Figure 9 (with more explanation underneath)**

    b. **First image**

    c. **Second image**

2. Have students view a map of lithium deposits in Nevada. Allow students time to make and share observations of the locations of these deposits, relating them to the process of lithium deposition in basins.

3. Have students return to the **HHMI EarthViewer** and their notes on it. Have them indicate times in which environmental conditions contributed to (steps leading up to deposition) or resulted in the formation of lithium deposits.

4. Discuss if students think the current tectonic activity occurring in Nevada could lead to the formation of additional lithium deposits.

Evaluate

1. Have students research other minerals (or rocks) that are mined in Nevada in terms of their formation/deposition and where they are found. Common minerals/rocks mined in Nevada include:
    a. Silver,
    b. Gold,
    c. Barite,
    d. Gypsum,
    e. Diatomite (rock),
    f. Aggregate (rock).

2. Students will create a diagram to show how their assigned mineral forms.

    a. You may want to provide copies or links to the diagrams in Elaborate to help students with ideas of how the image might be set up.

    b. Students can also look for an image of a “landscape cross section” as the base of their diagram.

3. You may want to have different groups research different minerals and then present on their mineral. Alternatively, jigsaw the groups so they can share information.