Plate Tectonics

Level: Grades 3–5
Facilitator Guide

LESSON DETAILS

Objective: Students will investigate how faults have changed the Nevada landscape and contributed to the formation of specific mineral deposits.

Standards

NVACSS and NGSS

- **4-ESS1-1:** Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.
- **4-ESS2-2:** Analyze and interpret data from maps to describe patterns of Earth's features.
- **3-PS2-1:** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- **DCI:** The History of Planet Earth; E Plate Tectonics and Large-Scale System Interactions; Forces and Motion
- **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

- foam block models (foam blocks, tape)
- play dough (2 colors)
- crayons or colored pencils
- copies of student handouts
- computer with internet access and projector
- small container and warm salt water (optional)

Lesson Summary

Students begin by using foam block models to test how applying forces can change their arrangement. Students then look at maps of Nevada, focusing on patterns in landforms throughout the state. A class discussion will help students relate the movement at faults to changes in Nevada's landscape. Students then use a model to show how mineral deposits can form in the cracks formed by fault movement. The lesson concludes with students viewing a map of earthquakes in Nevada to consider where they would want to explore for mineral resources.

Preparation

- For **Engage**, build a foam block model for each student group (Figure 1). It is recommended you line the faults with paper or tape so the blocks slide more easily past each other. Use markers to draw layers, which can facilitate discussion of the model as students can reference when layers do or do not line up. Access a **video from EarthScope Consortium** for more background and a demonstration of the use of these block models.

- For **Explore**, you may want to consider having extra copies of the handout for groups who try more than three forces.

- For **Elaborate**, you may want to set up a model to show how fluids can deposit minerals in faults. Roll out a small piece of playdough into a small, shallow container, then score the play dough with a knife, making a range of thin and wide cracks to represent faults (Figure 2). Cover the play dough with warm salt water (mix in enough salt that not all of it completely dissolves, to ensure a high concentration). Allow the model to sit until all the water is evaporated. You should see salt crystals on the top of the play dough, especially in the cracks.

Engage

1. Project images from an **article on earthquake damage in Nevada.** Click "View all photos" then scroll to the fourth image. Show images 4-15 one at a time, pausing on each image to have students make observations.

2. Ask students:

   - *What do you think caused this damage? Why do you think that?*

   - *In what direction(s) did the ground move? Use evidence from the pictures to describe how you know this movement occurred.*

3. Show the first image that you previously skipped over and discuss the map. The star indicates the epicenter of the earthquake, while the colors indicate the intensity of the shaking experienced by people in surrounding areas.

4. Ask students:

   - *If the earthquake occurred in Nevada, why are there more reports of intensity in California?*

   - *Why do you think the damage across an area when the map indicates that the earthquake was strongest at one location (point)?*

5. Show image two and explain that the green lines were added as a graphic to illustrate the movement and intensity differs with distance from the epicenter.

Explore

1. Provide a block model to each student group.

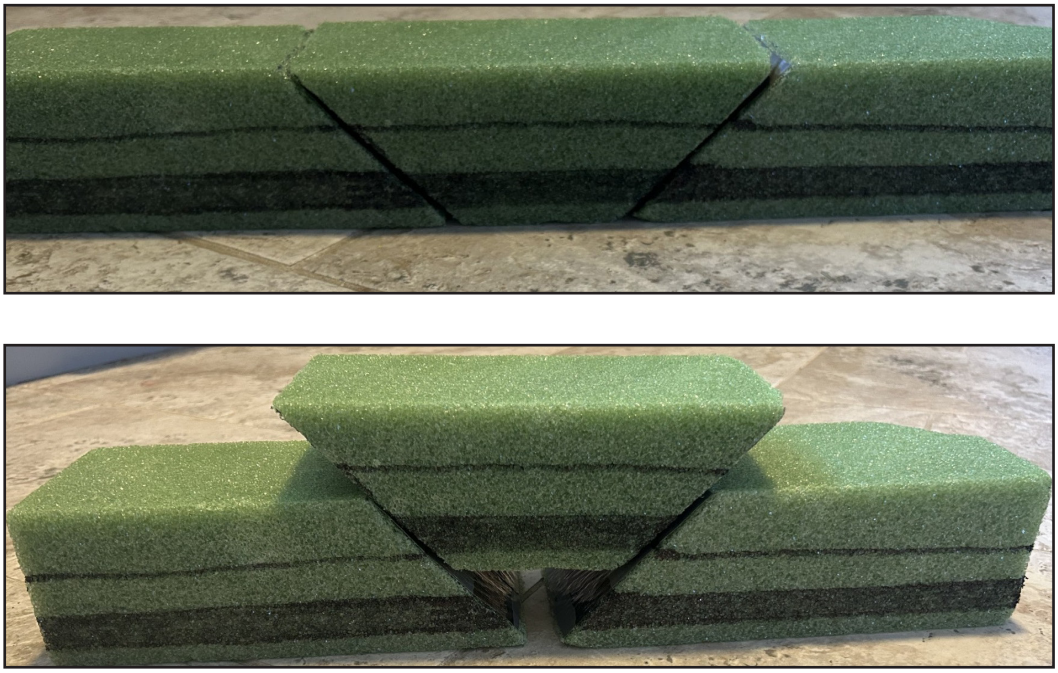

Figure 1. Block model with faults.

   a. Ask each group to discuss and predict how different types of forces will affect the movement of the blocks. Consider variables like pushing versus pulling, the strength of the force applied, influencing only one block, and the direction of force (up/down versus side-to-side).

   b. Have students record their predictions in the first column of their data table.

   c. Instruct students to experiment with applying the forces they discussed to the block model and record their observations of each trial in their data table.

   d. Facilitate a group discussion where students explain their observations.

   e. Encourage them to analyze why the blocks moved as they did under different types of forces and compare their findings with their initial predictions.

2. Discuss students results, then ask:

   ▸ *Were the forces you applied to the model balanced or unbalanced? What is your evidence?*

- *Is it possible to just move one point on the models? What happens when you try to push one spot on a block?* It may help to hold a model so that the middle block sits loosely between the other two, then shake the model so students can observe what happens.

- *How can you move the model to show what movement likely caused the damage in the images we viewed?* Project the images again, as needed.

Explain

1. Show students **earthquake data for Nevada**.

   a. The map defaults to showing fire data. Uncheck the chosen layer, then choose the earthquake icon (concentric circles) in the upper right corner of the screen.

   b. Click on the box by "Recent Earthquakes – Events by Magnitude" to turn on this layer. Click on the name of the layer to reveal the key that shows the strength of these earthquakes.

   c. Have students make observations of recent earthquakes in Nevada, most of which fall along the southwestern border of the state. Discuss why this area might have more earthquakes than the rest of the state. You may want to then have them look at earthquakes in California, noting that they mostly seem to occur along Northwest-Southeast "lines".

   d. Turn on the "National Seismic Hazard Map" layer (being sure that the PGA Ground Motion" sublayer is on). Ask students:

   - *What do you notice about the patterns of the colors on the map compared to where recent earthquakes have occurred?*

   - *What do you think the colors mean?*

   - *Why do you think these areas have a higher risk of earthquakes?*

   e. Turn on the "Quaternary Faults" layer (being sure that only the "Historical Ruptures" sublayer is on). Give students time to make observations, then discuss how most of Nevada's earthquakes occur in areas with these recent faults.

2. Relate back to the foam block models, describing the breaks as faults and the movement as being associated with earthquake events.

3. As you demonstrate with the models, discuss the immense force required to move large pieces of the ground. You may also want to discuss what other changes students think might occur at faults, in addition to movement:

   a. To prompt them to talk about temperature changes, have students press their hands firmly together and move one hand up or down. Discuss the change in temperature they experience.

   b. To prompt students to talk about pressure eroding rock or forming cracks in rock layers, break a cookie in half, press the two halves together, and move one half up or down.

Elaborate

1. Have students observe and discuss their observations of the following images. Students will likely observe that each image shows a crack in the rock layers (a fault), and that the fault is a different color than the surrounding rock.

   a. **Image C**

   b. **Image C** (although you may also want to discuss A and B)

2. Discuss that the material within the faults are minerals. Ask students:

   ▸ *Why do you think a mineral has formed here that is different from the surrounding rock?*

   ▸ *How do you think this mineral deposit may have formed?*

3. Provide each student with two small pieces of play dough, each a different color.

   a. Have students press the play dough into flat pieces.

   b. They will then place each piece on one of their palms.

   c. They should then press their hands together, with one palm slightly below the other.

   d. They should then press their hands firmly together while sliding them in opposite directions past each other.

   e. Have students separate their hands to make observations of the play dough, which should be slightly mixed together.

   f. Discuss how difficult it would be to separate the two colors of play dough and relate this to how pressure (and higher temperatures caused by this pressure) can alter the rocks and minerals at a fault.

4. Have students view **this animation** to further show how temperature and pressure can affect rocks and minerals.

5. Optionally, if you set up the play dough and salt model described in Preparation, have students view it and describe what they see.

Figure 2. Model of mineral deposits in faults. Salt has accumulated in cracks and uneven surfaces, and less so in flat areas of the model.

   a. Tell students how the model was set up and discuss what process this could demonstrate, with water flowing through faults and leaving behind concentrated mineral deposits.

   b. Discuss common minerals found along faults, such as gold, silver, clay, quartz and limestone.

Evaluate

1. Return to the map of **earthquake data for Nevada**.
2. Turn on the sublayers to show earthquakes of magnitude 5.00-7.00+ (as a challenge, also turn on the sublayer for 4.00-4.99 magnitude).
3. Provide students with a map of Nevada and have them color in areas where they would explore for minerals associated with faults. You may want them to consider:
   a. the cost of mineral exploration,
   b. where there are highways and cities (transport of minerals and people to work at the mines),
   c. elevation and terrain that might be difficult to explore.
4. Have students describe (in writing or through discussion) their choices.
5. Optionally, color students' suggestions on a large map poster or projection, then have students "vote" on an area. Check against the current **mineral and energy resources map** to see if exploration is currently occurring there.

HANDOUTS

Describe the force you applied to the model	Draw an image showing how the blocks moved in response to applied forces	Describe how the model moved in response to the applied forces

Relief Map of Nevada

Credit: By N. Zeemin, Inkscape, CC BY-SA 3.0