

## 5E Lesson Template

Lesson Author(s)	Natalie Eger
Lesson Title	Alluvial Fans Just on Earth?
Lesson Source	<a href="http://hi-seas.org/?cat=56">http://hi-seas.org/?cat=56</a> <a href="http://www.nps.gov/brca/forteachers/landformact3.htm">http://www.nps.gov/brca/forteachers/landformact3.htm</a>
Technology Needs (if any)	www.panoramio.com Google Earth--Mars YouTube
School	High School-10 <sup>th</sup> or 9 <sup>th</sup> grade
Math or Science?	Science
Lesson Concepts	Evidence of Water on Mars
Objectives	<p><b>Students will be able to:</b></p> <ul style="list-style-type: none"> <li>• Observe erosion caused by moving water</li> <li>• Discuss the landforms created by erosion</li> <li>• Relate these features to features found on Mars by the <i>Curiosity</i> rover</li> </ul>
CO State Standards	<p>Earth Systems Science</p> <p><input type="checkbox"/> Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet</p> <ol style="list-style-type: none"> <li>1. The history of the universe, solar system and Earth can be inferred from evidence left from past events <ol style="list-style-type: none"> <li>a. Develop, communicate, and justify an evidence-based scientific explanation addressing questions about Earth's history (DOK 1-3)</li> <li>b. Analyze and interpret data regarding Earth's history using direct and indirect evidence (DOK 1-2)</li> <li>c. Analyze and interpret data regarding the history of the universe using direct and indirect evidence (DOK 1-2)</li> <li>d. Seek, evaluate, and use a variety of specialized resources available from libraries, the Internet, and the community to find scientific information on Earth's history (DOK 1-2)</li> </ol> </li> </ol> <p>21<sup>st</sup> Century Skills</p> <ol style="list-style-type: none"> <li>2. How did the formation of Earth help shape its features today?</li> <li>3. How can we interpret the geologic history of an area?</li> </ol> <p>Relevance and Application</p>

	<p>2. Employ data-collection technology such as geographic mapping systems and visualization tools to gather and analyze data and scientific information about Earth’s history.</p> <p>Nature of Science:</p> <ol style="list-style-type: none"> <li>1. Understand that all scientific knowledge is subject to new evidence and that the presence of reproducible results yields a scientific theory. (DOK 1)</li> <li>2. Critically evaluate scientific claims in popular media and by peers regarding Earth’s history, and determine if evidence presented is appropriate and sufficient to support the claims. (DOK 2-3)</li> </ol> <p>2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet’s geosphere, atmosphere, and biosphere in a variety of ways</p> <ol style="list-style-type: none"> <li>d. Use specific equipment, technology, and resources such as satellite imagery, global positioning systems (GPS), global information systems (GIS), telescopes, video and image libraries, and computers to explore the universe )</li> </ol>
<p><b>Materials List and Advanced Preparation</b></p>	<p>Pandoramio.com Google Earth—Mars Constructing a water basin before class starts for demo. Explanation note worksheet</p>
<p><b>Safety</b></p>	<p>All classroom procedures will be followed. Students will not play with water basin. Clean up any spills from water basin. Monitor students’ activity on Internet.</p>
<p><b>Accommodations for Learners with Special Needs</b></p>	<p>Aid to work with student on Internet</p>

5Es

1. ENGAGEMENT		Time: 20 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<p>1. A demo will be used to demonstrate how alluvial fans are formed. (<a href="http://www.nps.gov/brca/forteachers/landformact3.htm">http://www.nps.gov/brca/forteachers/landformact3.htm</a>)</p> <p>2. Students will have a discussion about what occurred when the water was introduced.</p>	<ul style="list-style-type: none"> <li>• What happened when water was added?</li> <li>• What type of feature was formed?</li> <li>• What would happen if we increased or decreased the speed of water?</li> <li>• What if increased or decreased how much water we poured?</li> <li>• Where did the feature form?</li> <li>• What kind of environments would these formations be found?</li> <li>• What evidence do these formations give us or tell us?</li> </ul>	<ul style="list-style-type: none"> <li>• Students may not know the vocabulary words.</li> <li>• Students will be excited by the demonstration and may try to play with the basin.</li> <li>• Students may not understand what environments that alluvial fans form in.</li> <li>• Students may not make the connection that alluvial fans are associated with slopes and streams.</li> </ul>
<b>Evaluation/Decision Point Assessment</b>		<b>Student Outcomes</b>
Evaluation will be based on the group discussion students have. Every student must participate.		Students will understand what an alluvial fan or delta looks like.

2. EXPLORATION		Time: 50-60 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<ol style="list-style-type: none"> <li>1. Students will work in groups of two or three.</li> <li>2. Groups will do Google searches dry alluvial fans on Earth (<a href="http://www.atlasobscura.com/places/alluvial-fan">http://www.atlasobscura.com/places/alluvial-fan</a>)</li> <li>3. Next they will go onto Panoramio Google Maps and Google Earth to examine those dried up areas of water.</li> <li>4. They will label and measure the stream and the alluvial fan.</li> <li>5. They will provide evidence of how they know that location once had water.</li> <li>6. Students will share with other groups their findings.</li> </ol>	<ul style="list-style-type: none"> <li>• What places on Earth do not have water?</li> <li>• Was there water in that location before? Why or why not?</li> <li>• What evidence shows that we had water before?</li> <li>• Which direction did the water flow?</li> <li>• Do the alluvial fans flow into a river?</li> <li>• What other landform features are associated with the alluvial fan?</li> <li>• What kind of soil, rocks (sediment) did you notice with the pictures of alluvial fans you found?</li> <li>• Is there a lot of vegetation found by your alluvial fan?</li> </ul>	<ul style="list-style-type: none"> <li>• Students may forget what an alluvial fan is or what causes an alluvial fan to form.</li> <li>• Students may wonder why no water is present in some locations where alluvial fans have been found.</li> <li>• Students may confuse an alluvial fan with a delta.</li> </ul>
<b>Evaluation/Decision Point Assessment</b>		<b>Student Outcomes</b>
<ul style="list-style-type: none"> <li>• Students will print out their Google Earth maps where they examined dry stream beds.</li> <li>• Students will present their findings to the rest of the class.</li> </ul>		<ul style="list-style-type: none"> <li>• Students will search for alluvial fans on a global scale and identify other landforms that are associated with the formation of the alluvial fan.</li> </ul>

<b>3. EXPLANATION</b>		<b>Time: 30 Minutes</b>
<b>What the Teacher Will Do</b>	<b>Probing/Eliciting Questions</b>	<b>Student Responses and Misconceptions</b>
<ol style="list-style-type: none"> <li>1. A worksheet of vocabulary terms will be given to the students.</li> <li>2. They will define the terms with words and pictures using the Internet or textbook.</li> <li>3. After students finish their notes, they will then share with the rest of the class what they found.</li> </ol>	<ul style="list-style-type: none"> <li>• How do these terms relate to alluvial fans?</li> <li>• Why would we study sediment types?</li> <li>• What is the difference between alluvial fan and deltas?</li> <li>• Why do we distinguish between these two features?</li> </ul>	<ul style="list-style-type: none"> <li>• Students may struggle distinguishing between alluvial fans and deltas.</li> <li>• Students may not understand why we distinguish between alluvial fans and deltas.</li> <li>• Students may not be able to identify sediment types.</li> </ul>
<b>Evaluation/Decision Point Assessment</b>		<b>Student Outcomes</b>
Notes worksheet completed.		Students will be able to define key terms.

4. ELABORATION		Time: 30 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<ol style="list-style-type: none"> <li>1. Follow the directions for “Exploring Mars Through the Eyes of Curiosity” on Google Earth.</li> <li>2. Students will explore Gale Crater and look for erosional evidence (i.e. dry stream bed and alluvial fan.</li> <li>3. Students will make hypothesis of what could cause these landforms.</li> <li>4. Students will share with each other what they found.</li> <li>5. This video (2:27) will be shown to explain other scientists’ hypothesis. <a href="https://www.youtube.com/watch?v=mNXBfz1iVzC">https://www.youtube.com/watch?v=mNXBfz1iVzC</a></li> </ol>	<ul style="list-style-type: none"> <li>• Are the alluvial fans and stream beds similar to what you saw on Earth? Explain.</li> <li>• How could “dry ice” exist on Mars?</li> <li>• How does dry ice differ from water?</li> <li>• What is the chemical structure of dry ice? What is the chemical structure of water?</li> <li>• What form of matter is dry ice in?</li> </ul>	<ul style="list-style-type: none"> <li>• Students might not recognize the alluvial fan pattern on Mars.</li> <li>• Students may not know what dry ice is.</li> </ul>
Evaluation/Decision Point Assessment		Student Outcomes
Formative assessment in the form of students sharing their ideas. Questions answered in complete sentences on the worksheet.		Students will use evidence found on Earth to find similar features on Mars.

5. EVALUATION		Time: Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
Evaluation will be from all of the different activities and worksheets students completed.		
Differentiation		Time: N/A
Students who are behind or need support	For advanced or gifted students	
Work in partners. Assistance given by teacher.	Identify types of alluvial fans. Find more evidence of alluvial fans and stream beds on Mars.	

**ALLUVIAL FAN DEMO**

**Summary:** Deltas and alluvial fans are like identical twins: they look just alike! However, they are the result of similar depositional processes in very different environments. We take a closer look at these fan-shaped features in this activity.

**Instructional Method:** Demo

**Materials Needed:**

- Sand
- Flat large container
- Water
- Jar or small bucket

**Background:**

Alluvial fans and deltas are sedimentary landforms deposited by flowing water. From above you can easily see their fan, or pie wedge shape.

Alluvial (stream) deposits contain intermixed gravel, sand and cobble sized rocks. The size of sediment moved by a stream depends on the speed of the flowing water. The faster water flows, the larger sediment size the stream can carry. Sediment settles out of flow when stream flow slows down, meaning the energy decreases in flow. This happens as flow reaches a broad, flat surface or a standing body of water (like a lake or ocean).

Alluvial fans are often found at the base of arid / semiarid mountain ranges where intermittent streams flow. For a stream to be intermittent it flows only when it rains or snow melts. Sediment drops out of stream flow as energy decreases due to widening of the channel. Over time sediment builds up in the channels at the base of mountains and forces the stream to carve another channel. When channels fill in the process starts again. Streams filling in and moving to the side form fan shaped deposits. Alluvial fan examples can be found in Death Valley National Park and along the sides of the Colorado River at Grand Canyon National Park.

If intermittent activity continues over a long time the fan can grow very large, sometimes interconnecting with nearby fans forming a bajada. Death Valley National Park has well exposed examples of bajadas. In the west many people like to build on alluvial fan these deposits because they offer beautiful views of valleys and farmers like to farm them because of their fertile soil.

Deltas are similar to alluvial fans in shape, but are deposited in a different environment. Sediments that form deltas are transported in continuous flowing water. Delta deposits are found at the mouths of streams or rivers as they empty into lakes and oceans. As water flows into standing bodies of water, it loses energy and can no longer carry the sediment it once did. The sediment settles to the bottom and forms an underwater fan. Deltas get their name from their similarity to the triangular shape of the Greek letter "Delta". Examples of deltaic deposits are found at the end of the Mississippi River in the Gulf of Mexico and various smaller deltas located on the southern end of Florida.

River channels cross delta and alluvial fan deposits. As deposits thicken the channels shift side to side and continue forming new deltaic and alluvial fan structures. As old

deposits erode away, the river channel eventually migrates back to the original site and redeposits another fan or delta. The process continues until the river entirely changes course.

**Instructional Procedures:***1. Alluvial Fan*

Pour sand into a large plastic container with at least 2-3 inch high sides. You may want to experiment with both wet and dry sand.

Create adjoining mountains in the sand.

Pour a cup of water in the valley between the upper peaks of the adjoining mountains.

Make sure you pour the water at the same speed and in the same place.

Look for the resulting deposit at the base of the mountains. You may have to keep adding water until you see an alluvial fan form.

*2. Delta*

Create a mound of sand adjacent to each other and next to a standing body of water (i.e. add water to the pan so there is a "lake" at the base of the mound).

Repeat the same processes found in the Alluvial Fan instructions.

Look for the resulting deposit to form in the standing water.

Note: You may have to wait a few minutes to see the newly created delta because of all the floating sediment in the water.

**Discussion:**

Have students draw a sketch of the resulting deposit. Have them describe what happened to the sand as water was poured onto it. Will the same triangle shape be formed if a lot of water is used? If a little water is used? Do the shapes look similar in and out of the water?

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Class: \_\_\_\_\_



**Directions:** For each vocabulary term write a brief definition and draw an image that helps you understand the term.

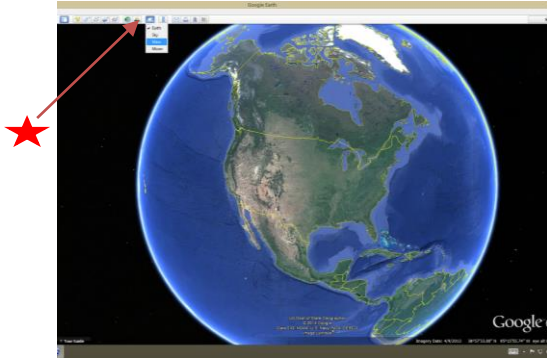
1. Sediment
2. Dissolved load
3. Suspended load
4. Competence
5. Gradient
6. Bed load
7. Erosion
8. **Directions:** Distinguish the differences between each feature. Draw a picture of what each feature looks like.


Alluvial fan	Delta

### Exploring Mars through the Eyes of *Curiosity*

**Directions: Use a separate piece of paper for your answers. Answer questions in complete sentences.**

1. Open Google Earth. Click on the planet icon at the top of the tool bar and select Mars.



2. In the search bar type “Gale Crater”. Zoom out to about 135.70 mi eye alt. On the side bar under layers click on the +  Mars Gallery. Click the + Robots and Landings. Next click the +MSL Curiosity Rover and uncheck the box for targets of Interest.
3. Zoom into the Curiosity Rover and click on the camera. Click onto the link titled “fly into this high-resolution photo.” Explore around. On separate paper explain what you see.
4. Zoom out and click into the outlined turquoise polygon. Explain what you see. Do you see any alluvial fans or streams?
5. Do these features look similar to what you viewed on Earth?
6. What type of erosion has occurred here? What was the geological agent that created these landforms?