

Activity #4

Evidence for an Atmosphere on Mars Over Time: Water Surface Features [Adult]



Adapted from: "Did Water Create Features On Mars?" from NASA's [Mars and Earth: Science and Learning Activities for Afterschool](http://tinyurl.com/pcfbln3): <http://tinyurl.com/pcfbln3> and [Rivers on Mars?](http://tinyurl.com/qfeqv4q): <http://tinyurl.com/qfeqv4q> with permission from the Lunar and Planetary Institute, LPI Contribution Number 1490. Unless otherwise noted, all images are courtesy of SETI Institute.

1. Introduction

In this activity, you will compare images of Mars and Earth surface features that have been eroded by water. Then you will construct, observe, and test a model of flowing water and look for similar erosion patterns. You will also "Think like a scientist. Be a Scientist!"

2. Science Objectives

You will:

- construct models to test ideas about processes that cannot be directly studied on Mars;
- ask experimental questions, collect data, and use evidence to answer those questions about flowing water erosion;
- relate evidence of *sustained flowing* water on Mars as support for a thicker early Martian atmosphere and a warmer climate more like Earth's; and
- appreciate evidence of ancient water erosion that points to changes in Mars' atmosphere over a very long period of time.

3. Materials

For each group of Cadettes: recommend teams of 4 Cadettes. Direct the Cadettes to find materials.

- [1] solid plastic growing tray (no holes), 28 x 53 x 6 cm (11 x 21 x 2.5 in) lined with a lightweight plastic sheet such as a paint drop cloth. Trays can be ordered from Amazon.com or found in local hardware stores. This will be your model **Stream Table**. Requires advance preparation, see [page 2](#).
- heterogeneous sand, includes fine-grained sand and some fine-grained soil, to cover surface of tray to a depth of 1 cm (0.4 in) or sufficient to smooth out any patterns in the bottom of the tray, plus additional heterogeneous sand to place on top of the plastic sheet to a depth of 3 cm (1.75 in) covering $\frac{1}{3}$ of the length of the tray.
- [1] conglomerate rock (purchased or collected as local laws permit); [view on carolina.com](http://tinyurl.com/kmcp7wo): <http://tinyurl.com/kmcp7wo>. **Note:** conglomerate rocks may also be collected along stream beds or near coastlines — be sure to check with local regulations before removing materials (see photo on [page 7](#)).
- [1] 1.0 liter (34 oz) disposable water bottle filled with tap water
- [1] plastic catch-bucket, about 4 liters (about 1 gal) or even larger for drainage water
- [3–4] thinly-sliced foam florist blocks to raise one end of the tray; [view on Amazon.com](http://tinyurl.com/knv57cc): <http://tinyurl.com/knv57cc>
- [1] protractor
- [4–5] assorted rocks from thumb- to palm-sized

- [2] colored pencils (2 per Cadette; any color)
- set of images: Mars and Earth (print from materials provided)
- newspapers to place under tray and bucket (for cleanup)
- (optional) latex gloves (caution: check for allergies), sponges, rags, and brooms



4. Safety Precautions

- 4.1. Keep area dry to reduce the chance of someone slipping on a wet floor. Place newspapers under the catch bucket and on the table to absorb excess water.
- 4.2. River bottom and other sources of heterogeneous sand may be contaminated with bacteria. It is recommended that gloves be provided for handling erosion material.

Advance Preparation

- If your pans have a pattern in the bottom, prepare the Stream Table: even out the surface with a thin layer of sand approximately 1 cm (0.4 in) deep before you lay the plastic cover over the top of this sand later.
- Use a pair of scissors and make a straw-sized water drain hole in the short side in the middle of the bottom edge of the tray.
- Cut a piece of thin plastic sheet several centimeters larger than the outside measurements of the tray. Lay the plastic over the thin layer of sand and make a hole in the plastic so that it lines up with the drain hole in the tray.
- Add 3 cm (1.2 in) of **very damp** mixed fine-grained sand and fill **no more** than $\frac{1}{3}$ the length of the tray away from the hole.
- TEST: Make sure the drain and plastic liner holes line up and that the excess water from the runoff will flow into the catch bucket on the floor.
- Use a serrated knife to slice several thin sections of florist foam so that Cadettes can adjust the tray to a slope of 10 degrees by placing the foam blocks under the end with the wet sand.
- Optional: assign jobs from “Cooperative Group Responsibilities” (see separate pdf document).



Sand layer preparation of tray



Final Tray Set up

5. Preparation for Activity #4

- 5.1. Read together *Background Evidence for an Atmosphere Over Time: Water Erosion* (see [page 7](#)). Discuss and answer the following about the images:
 - 5.1.1. What do you look for as evidence of *ancient* flowing water in an image?

Moving water erodes the sides of a river channel and the rocks and other particles (sediments) become part of the stream.

The sediments are carried further down stream and finer fragments are carried in the water. Some materials are dissolved in the water, too
 - 5.1.2. How does the evidence for ancient flowing water look different from continuously blowing wind?

Wind erosion often involves the movement of smaller particles.

Dunes are formed, and there is an absence of channels.

5.1.3. Equipment Manager: Retrieve the **conglomerate rock** and show it to everyone. Compare the sample of **conglomerate rock** to the images in Background reading. This type of rock can be found on Earth along swiftly flowing streams or at beaches with strong waves. NASA's *Curiosity* also found exposed conglomerate rock on Mars.

5.1.4. What does the conglomerate rock evidence suggest about the likelihood of sustained flowing water on Mars at some point in time?

The appearances of the conglomerate rocks on Earth and Mars are strikingly similar. The process involved in producing that type of rock on Earth involves swiftly moving water and, by analogy, suggests that Mars likely had sustained flowing water as well.

5.2. Watch this video: [River Fans on Earth and Mars \(JPL\): http://www.seti.org/ggtm](http://www.seti.org/ggtm)

5.2.1. How does observing alluvial fans on Earth and Mars help scientists learn more about Mars?

Scientists can use what they understand about the erosion processes on Earth to better explain what might have happened on a far-away planet like Mars. Scientists can also experiment with how alluvial fans are formed on Earth.

5.3. Guided Sensory Imaging: Think about the *feel* of moving water.

Equipment Manager: Get a palm-sized amount of sand and place that sand in a teammate's hand. While standing over the bucket container, ask your teammate to close her eyes and pour water slowly over the sand. What is happening to the sand particles in her hand? Ask her to describe how it feels.

5.3.1. Repeat this mini-experiment for everyone if time permits. Consider how sand particles move objects and also "sands" them smooth. How do you imagine these Earth surface features might form from sustained flowing water?

Moving water erodes the surface of planets by carrying solid material. Cadettes should feel the particles of sand moving and pushing against their fingers, imagining how the process might alter the planetary surface.

6. Go and Explore

6.1. Equipment Manager: Use the protractor and different combinations of slices of florist foam to prop up the short side of your stream table until the side with the sand is lifted about 10 degrees.

6.2. Leader-organizer: Line up the hole in the pan with the catch-bucket on the floor. **TEST:** Make sure that any water from the pan flows out of the drain hole at the end and into the bucket.

6.3. Check that newspapers are under the bucket and your Stream Table.



Prop up the sand-filled end 10 degrees with foam slices.

6.4. Group takes turns for steps 6.4–6.6: Begin pouring water from the water bottle **slowly** and steadily over the top of the wet sand until the water flows down the plastic area and out the hole in the pan into the bucket, checking to make sure the water flows into the bucket.

6.5. Observe the channels that form in the sand. Keep pouring, observing the movement of the particles. Look for signs of erosion and channels. Are all the particles moving at the same speed?

No

6.5.1. What happens to the particles when the water slows down at the end of the tray?

Depending upon where Cadettes pour the water (in one place or across the entire end of the pan), shallow channels form and the particles travel from the top towards the open bottom area. Smaller particles typically move faster down the channel.

6.5.2. What types of surface features did you observe?

Slowly flowing water produces more meandering channels that are easily diverted by small rocks and other obstacles. Multiple small channels may appear.

6.6. Now experiment and find out what happens in a flood. Pour water **faster** down one channel.

6.6.1. What happens to some of the particles as the water flows over old channels?

Old channels are altered and incorporated into one newly formed deep channel. Small particles move down stream and into the open area of the Stream Table.

6.6.2. What kinds of new features did you make? Once the water has gone away, what features are left at the end of the channel? (Review your Background reading.)

One or more alluvial fans are observed in the video and in background images on pages 7-8.

6.7. Test your own idea — advance preparation.

Group: Look at the selection of rocks and consider an erosion effect you want to test.

6.7.1. Using the protractor as a scraper, smooth the sand so the channels are largely covered over.

6.7.2. Decide: Will you pour the water slow or fast?

6.7.3. Think about the effect of adding rocks in different places along the channel(s) you will produce.

6.7.4. Make a Prediction: What will happen when water rushes by? How will the rocks affect the flow of water?

Rocks divert the flow of water, creating new channels and slowing the particles down.

6.7.5. Sketch your Stream Table setup with the rocks in your Data Sheet.

Varies with set-up.

6.7.6. Using a colored pencil, briefly sketch your **Start** conditions, including the rock location and sand features formed by water.

6.8. Now Do It! Run your experiment and see if your prediction was accurate.

6.8.1. Pour water to produce the channel(s).

6.8.2. Add the rock(s) as planned.

6.8.3. Sketch the Stream Table.

6.8.4. Pour water to observe the effect of the adding rocks.

6.8.5. Add the new observations to your sketch by using a different pencil color.

7. Cleanup

Everyone participates in cleanup.

- 7.1. Follow your adult leaders' directions.
- 7.2. Dump the water outside. Do not pour the contents of the waste water down the sink. Sand is not good for drains!
- 7.3. Clean up spilled water on tables, counters, and floors with towels or rags.
- 7.4. Dispose of newspapers as directed.

8. Data Sheet and Information Processing

Test your own idea.

Sketch the water flow before and after you add rocks. Use different pencil colors to show the change in appearance. Draw the rocks.

Pencil Key: Color

Start:

End:

8.1. Group Work:

8.1.1. If you saw the same erosion surface features on another planet, how do you think those surface features might have happened? Together as a group, watch video clip: [River channels on Mars \(BBC\)](http://www.seti.org/ggtm): <http://www.seti.org/ggtm>

8.1.2. What does the presence of surface features created by sources of sustained flowing water suggest about the possibility of more atmospheric pressure on Mars in the past? (Hard question — reflect on our second activity, “The Goldilocks Question.”)

This presence suggests that younger Mars had a thicker atmosphere and was warm enough to support liquid water on its surface, a big change from then to now.

8.1.3. What can happen when Mars’ atmospheric pressure is low and there are small molecules like water vapor near the surface?

If the atmosphere pressure is low, there is less gravity, and it is easier for the light water vapor to escape.

8.2. Summary for Group Presentation (4 or 5 minutes). Now look at the images of Mars: Do you see evidence for “flowing water” on Mars? Review images, video clip, and your experimental model of stream surface features.

9. Connection to the Leadership Journey *Breathe. It’s Your Planet — Love It!*

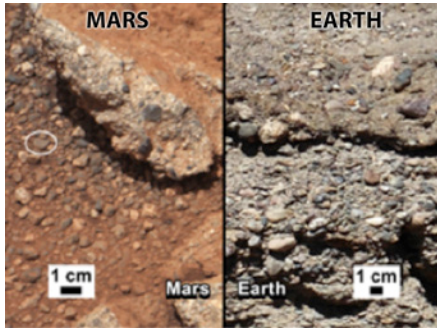
Start thinking about why the atmosphere and Global Warming are important to you. Activity #5 will help you understand Global Warming.

Activity #4: BACKGROUND Evidence for an Atmosphere Over Time: Water Erosion

Like fingerprints, there are surface features that appear as a result of sustained flowing water and erosion (wearing away). Water shapes a planet's surface features along with the other forces of blowing wind, volcanic eruptions, plate tectonics, and impacts of large objects from space such as asteroids. What does continuously flowing water do? Water erodes channels, moves large and small particles long distances, and deposits materials over wide areas. Continuously blowing wind also moves materials over wide areas as well.

Water Erosion

What surface features are observed as a result of sustained flowing water?



Conglomerate rock. Image credit: NASA MRO

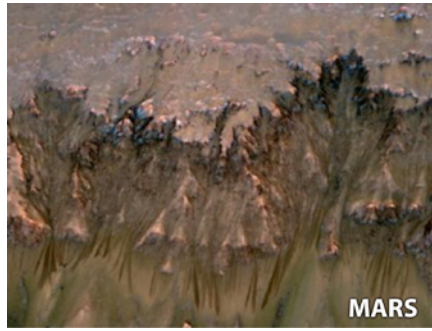


Image credit: NASA/JPL-Caltech/MSSS and PSI

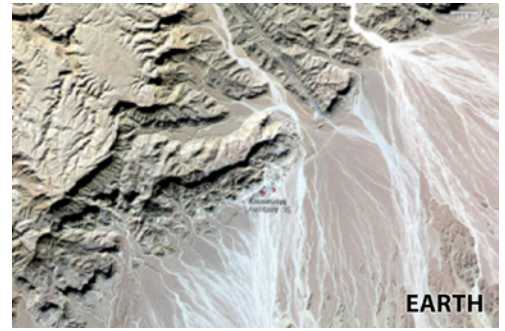

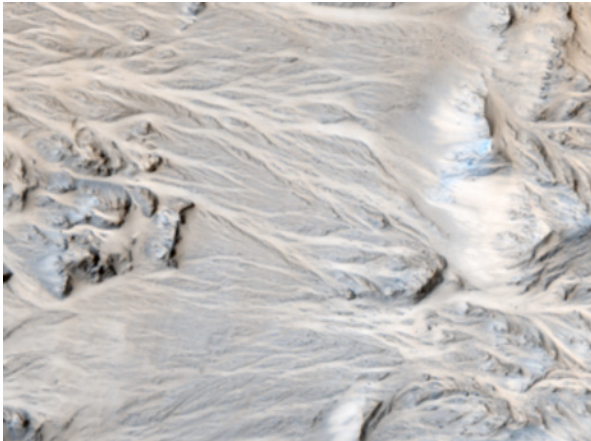

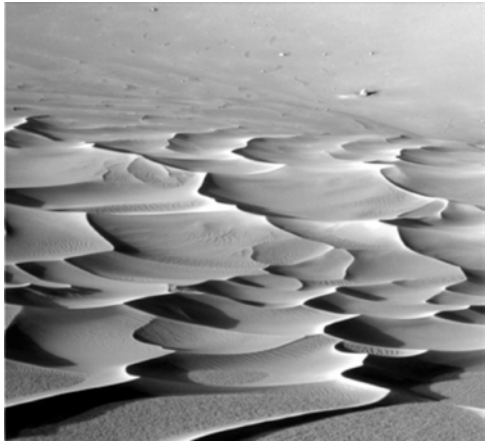

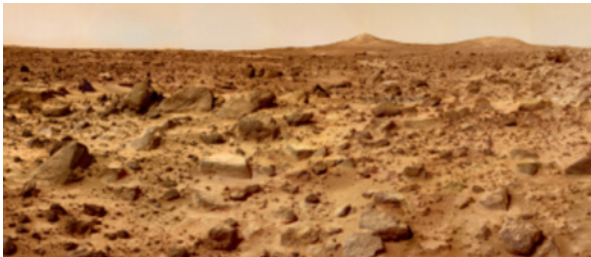


Image credit: NASA/JPL/ASTER

- Moving water erodes the sides of a river channel and the rocks and other particles (sediments) become part of the stream.
- The sediments are carried further down stream and finer fragments are carried in the water. Some materials are dissolved in the water too.
- A river channel may widen or narrow as sediments are picked up or dropped along the way. As the river channel changes its size, the water will also change how fast it flows.
- Eventually, the stream flow slows enough for the grains to be completely dropped. Areas where more particles are dropped from rivers at the base of a mountain form *alluvial* or *flood* plains.

You will observe alluvial fans in the video and also experiment with how they are produced.

Wind and Water Erosion

	Earth	Mars
<p>Water Erosion</p> <p>Alluvial Fan</p>	<p>Death Valley</p>  <p><i>Image credit: USGS</i></p>	<p>Mars Mojave Crater</p>  <p><i>Image credit: NASA MRO</i></p>
<p>Wind Erosion</p> <p>Dunes</p>	<p>Rub' al Khali, Saudi Arabia</p>  <p><i>Image credit: Nepenthes</i></p>	<p>Mars Dunes</p>  <p><i>Image credit: NASA JPL Rover</i></p>
<p>Wind Erosion</p>	<p>Turpan Depression, China</p>  <p><i>Image credit: USGS</i></p>	<p>Mars</p>  <p><i>Image credit: NASA Mars Pathfinder</i></p>