# Activity #4
# Evidence for an Atmosphere on Mars Over Time: Water Surface Features *[Cadette]*

Adapted from: "Did Water Create Features On Mars?" from NASA's *Mars and Earth: Science and Learning Activities for Afterschool:* http://tinyurl.com/pcfbln3 and *Rivers on Mars?:* 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. Pick up your materials as directed by your adult leader.

- [1] model **Stream Table**
- [1] conglomerate rock
- [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
- [1] protractor
- [4–5] assorted rocks from thumb- to palm-sized
- [2] colored pencils (2 per Cadette; any color)
- 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.

## Preparation for Activity #4

4.3. Read together *Background Evidence for an Atmosphere Over Time: Water Erosion* (see page 6). Discuss and answer the following about the images:

4.3.1. What do you look for as evidence of *ancient* flowing water in an image?

4.3.2. How does the evidence for ancient flowing water look different from continuously blowing wind?

4.3.3. 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.

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

4.4. Watch this video: *River Fans on Earth and Mars* (JPL): http://www.seti.org/ggtm

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

**4.5. 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.

4.5.1. 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?

## 5. Go and Explore

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

5.1. 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.

5.2. 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.

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

**5.4. Group takes turns for steps 5.4–5.6:** 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.

5.5. 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?

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

5.5.2. What types of surface features did you observe?

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

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

5.6.2. 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.)

**5.7. Test your own idea — advance preparation.**
Group: Look at the selection of rocks and consider an erosion effect you want to test.

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

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

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

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

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

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

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

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

5.8.2. Add the rock(s) as planned.

5.8.3. Sketch the Stream Table.

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

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

## 6. Cleanup

Everyone participates in cleanup.

6.1. Follow your adult leaders' directions.

6.2. Dump the water outside. Do not pour the contents of the waste water down the sink. Sand is not good for drains!

6.3. Clean up spilled water on tables, counters, and floors with towels or rags.

6.4. Dispose of newspapers as directed.

## 7. 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:

7.1. Group Work:

7.1.1. 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

7.1.2. 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.")

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

7.2. 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.

## 8. Connection to the Leadership Journey *Breathe. It's Your Planet — Love It!*

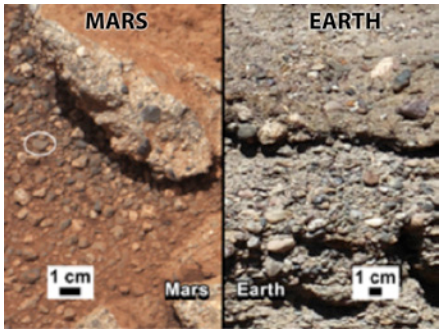
Start thinking about why the atmosphere and Global Warming are important to you. Activity #5 will help you understand Global Warming.

## 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*

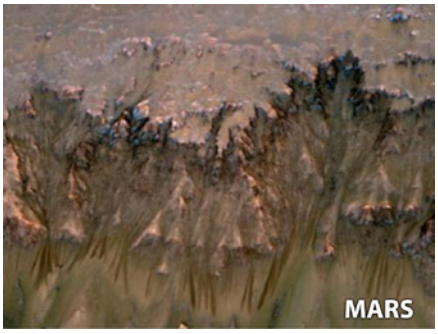



*Image credit: NASA/JPL-Caltech/MSSS and PSI*

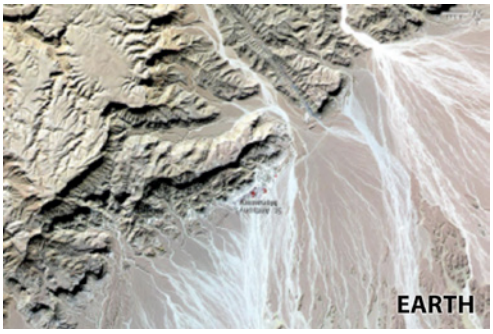
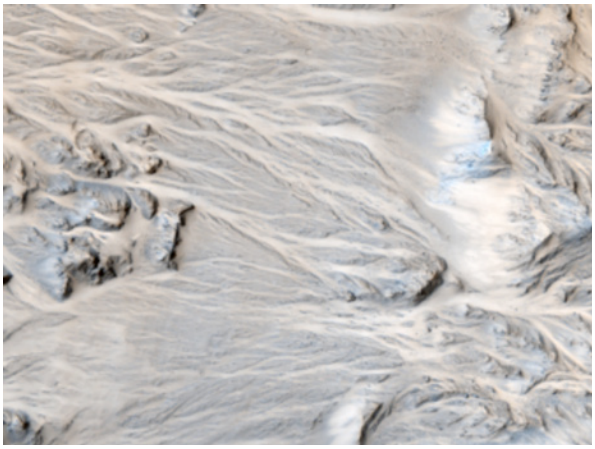
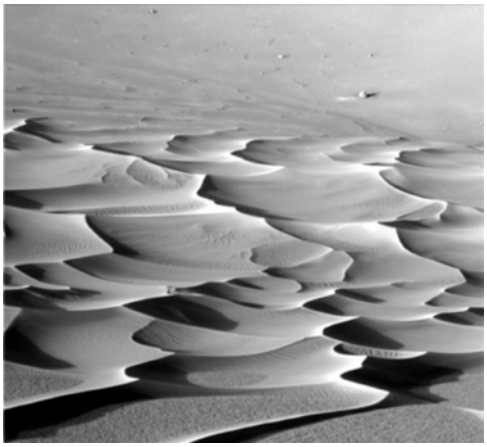



*Image credit: NASA/JPL/ASTER*

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