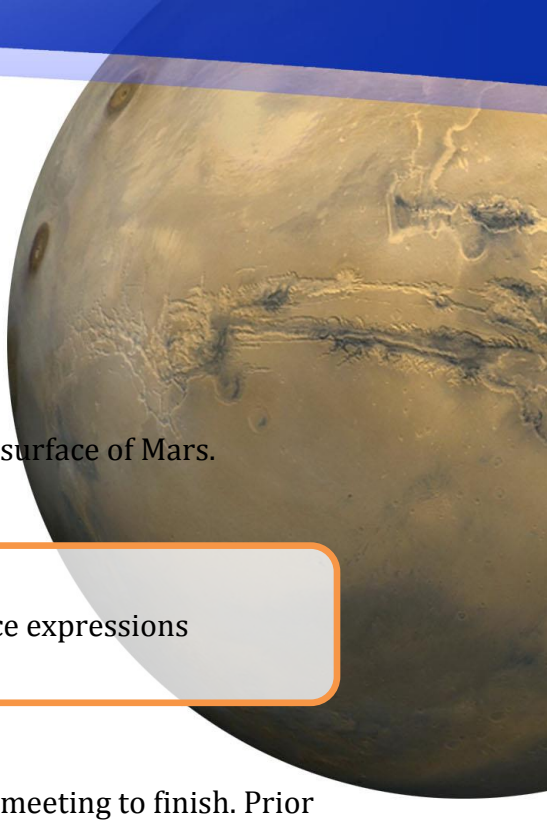

Lesson 13: The Water Underneath: Groundwater

Summary
A learning module for incorporation in to Earth science courses that exposes students to the influence of groundwater and on the surface of Mars.

Learning Goals

Students will be able to:

- See how water movement underground produces surface expressions
- Simulate and observe catastrophic flow behavior

Context for Use
This lab and associated discussion will likely take the entire class meeting to finish. Prior exposure to concepts of the zone of saturation (saturated, water-filled pores), water table, and permeability is advisable although not necessary to be successful in the lab.

Description and Teaching Materials
In-Class Activity

In-Class Activity 1: Water Underneath: Mars Groundwater

Catastrophic Flow Experiment (see Reference below)

Teaching Notes and Tips

1. We encourage instructors to have their own template for having students write up the lab experiment (this makes it easier to grade and find the student answers).
2. This experiment works well for small groups of students (3-4). For large classes >20, one could also simply provide a demonstration and ask students for their hypothesis and what they believe will result from the experiment.
3. Some researchers propose that many of the deep channels and canyons found on Mars might be the result of catastrophic flow from groundwater seepage.

Assessment
Methods of assessment are within each individual *In-Class Activity* and *Homework*.

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Mars for Earthlings

References and Resources

Student Homework 1 Version on Catastrophic Flow:

You may want to develop your own homework on Catastrophic Flow, and use a website like this to see if students can detect catastrophic flow on Mars.

http://www.nasa.gov/mission_pages/MRO/news/mro20130120.html#.UkBtIFMgrnh

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In-Class Activity 1
The Water Underneath: Mars Groundwater
Catastrophic Flow Experiment
Adapted from J. Weller Cochise College, AZ (2008)

Purpose: To conduct a small benchtop experiment to understand the surface expressions of groundwater springs, sapping, and gullies.

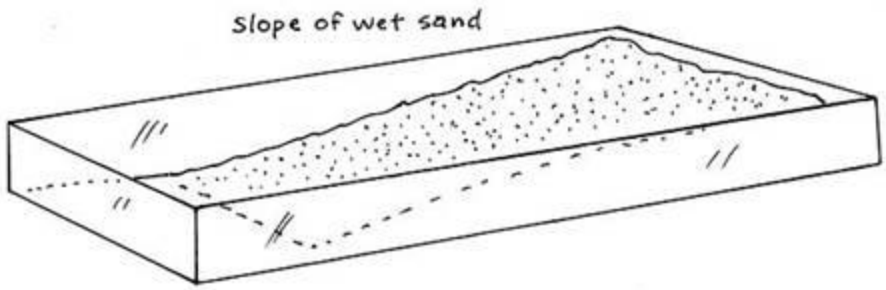
Preparation: This can be a bit messy, so it is good to have an area where there are sinks and clean up facilities.

1. Acquire some large plastic tub containers and fill them with loose sand to create a mini sandbox. (a 1.5-2 feet long and 1-1.5 feet wide tub works well, but larger sizes can also be used)
2. Have a supply of plastic ziplock bags (could try both quart and gallon size dependent on the size of the plastic tub and the amount of sand.

Engage
Have students look up groundwater sapping images of Mars (e.g., Noachis Terra) on the internet and examples on Earth.

Explore (Experiment)
Using the sandbox let's try to see if we can duplicate some of the features seen in the Martian photographs.

1. First, fill a gallon-size zip-lock plastic bag with water. Try not to leave any air in the bag.
2. Next, create a long low slope of wet sand in the sandbox.



Credit: J. Weller/Cochise College, AZ (2008)

3. At the top of the slope bury the plastic bag of water so that one corner of the bag slightly sticks out of the slope.

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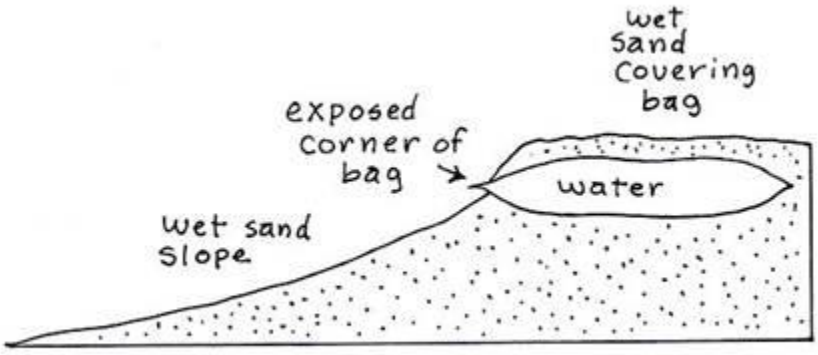

Credit: J. Weller/Cochise College, AZ (2008)

4. Cover the bag with about one inch of wet sand. The water in the bag sloshes around; so smooth the surface above the bag so that there are no cracks at the surface.
5. Dust the slope with a very thin layer of dark dirt. This will help show the flow channel better.
6. With a pair of good scissors, quickly cut off about one inch of the exposed corner of the water-filled plastic bag, setting off the flood and collapse.

Explain

1. Would the rate of water outflow change the surface expression? Why or why not?

2. Consider a liquid with higher viscosity then water (e.g. molasses), that might be used in the bag. Would the surface expression change?

3. This hypothesis is considered by many Mars researchers to be the cause of extensive deep channels and canyons present on the surface of Mars. Does groundwater sapping seem plausible as a formation mechanism for channels on Mars? Can it account for channeling as large and deep as Valles Marineris? Why or why not?

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Elaborate
Direct students to look at more detailed simulations of erosion and sapping to further explain channel systems on Mars.

Possible resources:
http://erode.evsc.virginia.edu/marssap.htm

Evaluate
Researchers propose that gullies and channels might be formed by the groundwater sapping. However, there could be more recent dry flows within the same channels. See this HiRISE flyover video: http://www.youtube.com/watch?v=mgzl3l9bS_g