

Lesson 12: Surface Sculpting Waters on Mars

Summary

This learning module and related laboratory exercise exposes students to surface water erosion due to rivers and deltas and their evidence on the Martian landscape. Students will use modern analogs to assess the hypothesis that both rivers and deltas existed on Mars.

Learning Goals

Students will be able to:

- Demonstrate comprehension of fluvial styles and processes as well as delta formation through comparison of Earth-analog environments and Mars imaging.
- Gain experience with contour maps on both Earth & Mars.

Context for Use

This learning module is meant for adaptation in an introductory Earth science course and/or planetary science course. If you desire to use the *In-Class Activity 1: Stream Table and Mars*, provide exposure to fluvial processes and styles prior to the activity.

Description and Teaching Materials

In-Class Activity

In-Class Activity 1: Carving Mars:
Rivers

In-Class Activity 2: Eberswalde Delta
Mars

Homework/Lab

Homework 1: Mars Fluvial Channels:
Contour Maps

Teaching Notes and Tips

1. If you have access to a stream table conduct the “Stream Table and Mars” *In-Class Activity* in the stream table lab.

2. For larger classes (>20 students) in the “Stream Table and Mars” *In-Class Activity* use the video link provided in References and Resources and ask for volunteers to sketch out fluvial events on the board for others to explain and discuss. Encourage all students to participate and turn in their sketches for a participation grade.
3. All images required for activities/homework are available in the References and Resources in PowerPoint format.
4. Acquire red/blue glasses to view HIRISE red-blue anaglyph images.

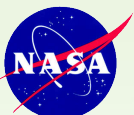
Assessment

Each *In-Class Activity* and *Homework* has its own measure of Assessment.

Mars for Earthlings

References and Resources

1. Image File: [Surface Sculpting Waters](#)
2. Stream Table: meandering river-
<http://www.youtube.com/watch?v=YsQ7hW2fAEs&feature=related>
3. Boggs, S., 2001. Principles of Sedimentology and Stratigraphy, 3rd ed. Prentice Hall, ISBN: 0-13-099696-3, 726p.
4. Mars Global Surveyor image & Video of Martian delta:
http://www.nasa.gov/multimedia/imagegallery/image_feature_98.html
5. Red-blue glass anaglyph glasses example from Amazon: <http://www.amazon.com/Red-Blue-Anaglyphic-Glasses-Paper/dp/B002MXP42W>
6. Ehlmann B., et al. 2008. Clay minerals in delta deposits and organic preservation potential on Mars, Nature Geoscience, doi:10.1038/ngeo207.
7. Bhattacharya, J., and Giosan, L., 2003. Wave-influenced deltas: geomorphological implications for facies reconstruction, Sedimentology, v. 50, p. 187-210.
8. Water flows on Mars presented by Alfred McEwen (choose the video under “Possible Water Flows on Mars”): <http://mars.jpl.nasa.gov/mro/multimedia/videoarchive/>



Mars for Earthlings

In-Class Activity 1

Surface Water_MFE

Carving Mars: Rivers

Purpose: Observe the formation of fluvial channels, the effects associated with varying water velocity and changing base/level gradient, and the evidence for fluvial/alluvial environments on Mars.

Preparation:

1. Acquire red/blue glasses to view HIRISE red-blue anaglyph images (<http://www.amazon.com/Red-Blue-Anaglyphic-Glasses-Paper/dp/B002MXP42W>).
2. Expose students to fluvial styles and fluvial processes (meandering vs. braided channels, base level fluctuation, changing stream gradient etc.) on Earth and how they are formed **prior to** conducting this *In-Class Activity*.

Resources:

1. Stream Table by Davidson Geology: meandering river- <http://www.youtube.com/watch?v=YsQ7hW2fAEs&feature=related>
2. Eberswalde Delta-HIRISE: (context) http://hirise.lpl.arizona.edu/PSP_001534_1560
Image: <http://hirise.lpl.arizona.edu/images/2007/details/cut/Eberswalde-delta-3x.jpg>
3. MOLA global map: <http://www.google.com/mars/>
4. Meander Scar Image Source: ftp://eol.jsc.nasa.gov/EFS_highres_ISS022_ISS022-E-19513.JPG
5. Water flows on Mars (choose the video under “Possible Water Flows on Mars”): <http://mars.jpl.nasa.gov/mro/multimedia/videoarchive/>

Engage

Watch the following video: <https://www.youtube.com/watch?v=E6sWiPAu708>

As the students watch the video, have them answer the following:

- a. Where is the river fastest?
- b. Where do sandbars form?
- c. Why does the river form sinuous bends?



Mars for Earthlings

Explore

1. Have students observe the Davidson Geology stream table experiment:
<http://www.youtube.com/watch?v=YsQ7hW2fAEs&feature=related>
 - a. Students should sketch and label the timestamp associated with the following fluvial events:
 - i. Formation of a cut bank
 - ii. Formation of a point bar
 - iii. Stream avulsion
 - iv. Formation of multiple channels (at least more than 1)
 - b. For each of the sketches have students describe why they occurred.
 - i. Cut bank
 - ii. Point Bar
 - iii. Stream Avulsion
 - iv. Multiple channels
 - c. As students progress through the Exploration portion of the exercise discuss the terms and concepts:
 - i. Cut bank
 - ii. Point Bar
 - iii. Meandering vs. braided
2. Explore the HIRSE anaglyph image, using red-blue glasses (blue filter over right eye), of the Eberswalde region of Mars:
<http://hirise.lpl.arizona.edu/images/2007/details/cut/Eberswalde-delta-3x.jpg>
 - a. Ask the students if any of their stream table sketches are similar to what they observe on Mars? Which one, if any?
 - b. Explain the circumstances in which this surface geomorphology on Mars might have formed.

Explain

1. Students can use Google Earth to show continental areas on Earth (e.g. look in high mountainous areas) where multi-stacked channel styles are prevalent. Do the same for braided vs. meandering styles. In doing so, discuss the following concepts:
 - a. Channel gradient
 - b. Sediment input

Elaborate

Make a Mars global map available for students to view digitally or hardcopy:

<http://www.google.com/mars/>

1. Consider the landscape of Mars. In what regions, could water have flowed as braided channels? Ask students to label a map or directly point out their response.
2. Would meandering or braided fluvial styles be more common on Mars? How does this differ from Earth, or does it?



Mars for Earthlings

Evaluate

1. In reference to figure 1 ask:
 - a. Where would it be safe to build a house?
 - b. Where is deposition occurring? What about erosion?
2. When students see the scars, ask the class:
 - a. What does this tell you about the meanders?
 - b. Can the students discern which meanders are older and which are younger?
 - c. Did they observe similar geomorphology on Mars?

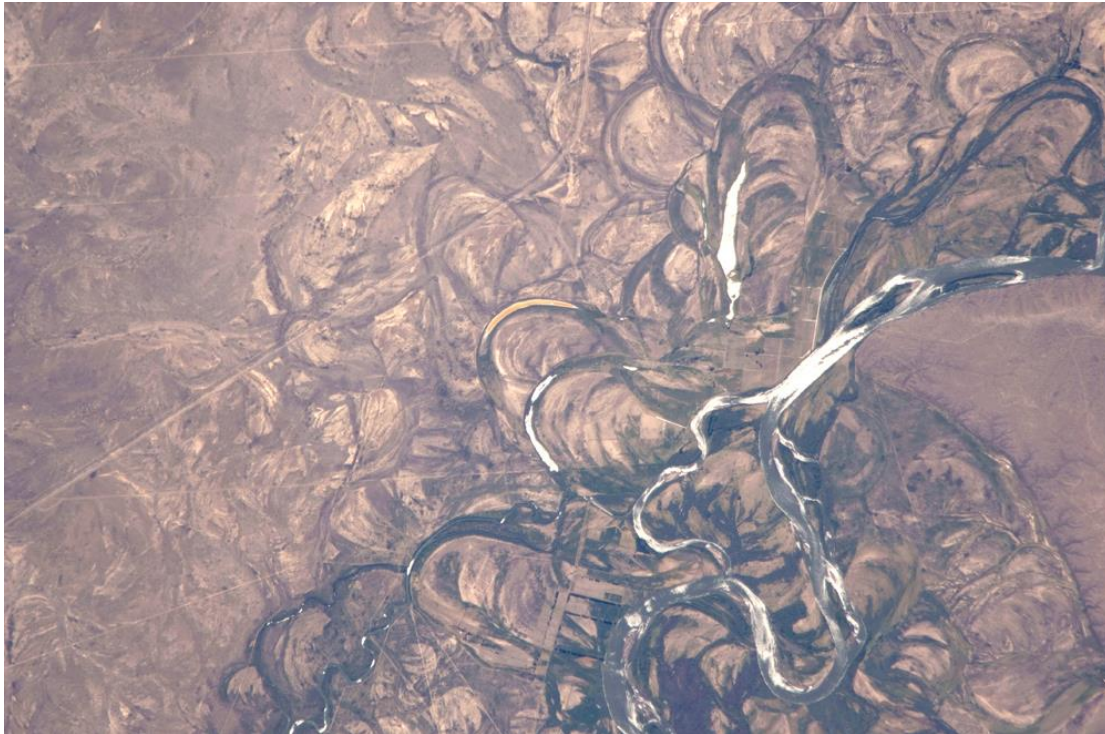


Figure 1: RIO NEGRO, COLONEL JOSEFA AREA, FLOOD PLAIN

Center Point Latitude: -39.8 Center Point Longitude: -65.4

Credit NASA. (Image Source: ftp://eol.jsc.nasa.gov/EFS_highres_ISS022_ISS022-E-19513.JPG. ISS/NASA)