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.

Sponsored by:
National Aeronautics
and Space Administration
NASA Award (NNX11AH29G)

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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/

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In-Class Activity 2
Surface Water_MFE
Eberswalde Delta Mars

Purpose: Become acquainted with deltas on Earth and apply the principles of delta-formation to Mars images. Students will be able to create an informed hypothesis as to whether or not deltas are present on Mars.

Preparation

1. Acquaint students with delta formation previous to this exercise or as a simultaneous component to your teaching.
2. Research and present deltas found here on Earth to serve as analog comparisons. The **Engagement** section will provide an opportunity, albeit small, for students to see an analog.

Engage

1. Ask students the following question to start off the activity: When you hear the word "delta" what do you think of?
    a. List ideas on board
    b. Discuss each one as it applies
2. To test current understanding share with them the following images and have them identify which is a "delta" (see the Image file in **References and Resources** for images).
    a. Horseshoe Bend Colorado
    b. Lake Powell
    c. Amazon Delta
    d. Congo River

Explore

1. View the following video from NASA.gov- click on the "+ View Video" link in blue: http://www.nasa.gov/multimedia/imagegallery/image_feature_98.html

2. As students view the video, ask them to write down the evidence cited by scientists that this is a delta on Mars.

3. Ask students to compare and contrast their Mars findings with Earth-based observations of the following deltas: Mississippi River and Colorado River (dry).
    a. You may use a similar Table Format provided in this learning module if you plan to have students turn in their observations as a result of this *In-Class Activity*
    b. See the Image file in **References and Resources** for images.

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Delta	Overall Geometry	What body is/was it emptying into? Evidence?
Eberswalde Crater, Mars		
Mississippi River, Earth		

Explain

1. As students complete the **Explore** activity, discuss concepts such as delta *lobe switching* and the *forces creating different delta geometries* (bird's foot vs. cuspate).
2. As appropriate share the tripartite classification (consult Bhattacharya & Giosan, 2003 **References and Resources**) of deltas and which would be more applicable on Mars (Ehlmann et al., 2008 **References and Resources**), if any.

Elaborate

1. Search and discover other deltas on Earth via Google Image search or the like (HINT: search major river systems). Have students determine which delta on Earth is most similar to Eberswalde Delta on Mars. Are any a good match? Ask students to explain why or why not.
2. Ask students how they might conduct "tests" on Mars to determine whether or not a delta exists? (Hint: remember that deltas form where sediment is dispersed into a standing body or former standing body of water.)

Evaluate

1. If you use this activity as homework, have students submit the chart and associated questions and assess their answers.
2. If you use the Elaboration section, the tests students come up with should indicate their grasp of delta processes.