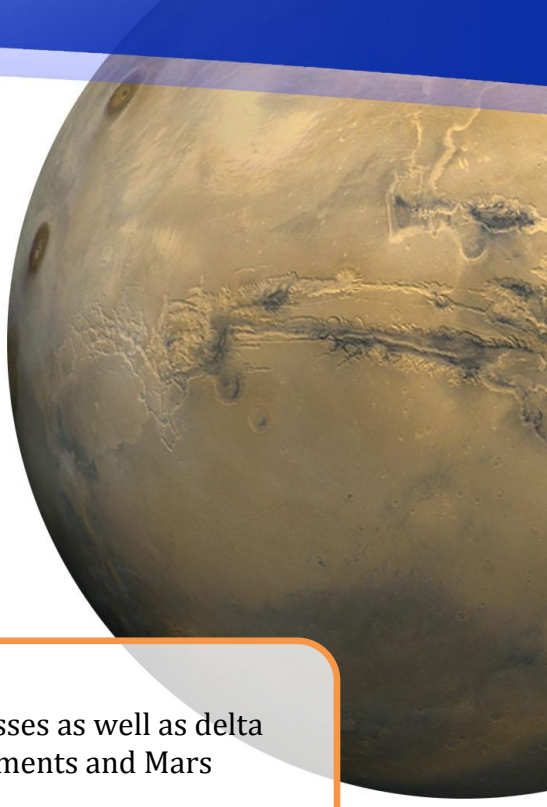

Lesson 12: Surface Sculpting Waters on Mars

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.

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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

Homework 1
Surface Water_MFE
Mars Fluvial Channels: Contour Maps

Purpose: Become familiar with contour maps and learn how to read them. Observe fluvial incised-channels on a contour map of Earth and compare to a contour map of Mars, and make predictions of potential fluvial activity on Mars.

Preparation:

1. If not uploaded to the students' Google Earth application, load the USGS topographic maps layer to Google Earth using the following website and link: http://www.gelib.com/ng-topo.htm
2. Open the Mars contour map found here: http://pubs.usgs.gov/imap/i2782/i2782_sh2.pdf

Directions/Questions:
Earth Fluvial Channels

1. Open Google Earth:
    a. Have the students get their bearings on Earth by centering their map/viewer on the following coordinates:38°27'N, 109°41'W, near Pyramid Butte, UT.

    b. What is the major river in the area?

    c. Find Dripping Spring (southeast of Pyramid Butte). What is the flow direction from Dripping Spring to the nearby major river?

    How do the contour lines indicate the flow direction? Sketch an example below of what the contour lines look like in relationship to the stream:

    d. If the students were to hike from Pyramid Butte to the nearby campground in the northeast, would they be hiking uphill or downhill? Have them explain their reasoning.

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e. Follow the meanders of the major river channel. How are the contours drawn near the river? Do they follow the river? Cross the river? Explain the reason why the contours are drawn that way.

f. Using the ruler tool, estimate the distance in miles from Pyramid Butte to Musselman Arch to the southwest.

g. Zoom in on the Goosenecks of the major river. Zoom in enough to see the annotated hand-drawn sand bars of the river. Explain the origin of the sand bars and whether or not you could hike out of the Goosenecks easily.

h. Is the white area where the words "Goosenecks" are written an area of relief or a depression? Have students explain their reasoning.

Mars Fluvial Channels

2. Using the Mars contour map, find Valles Marineris. Look northeast of Valles Marineris, around the 330E/30W longitude line and the Martian equator.
   a. What features stand out/are enhanced by the contour data (mountains, rivers, craters etc.)?

   b. Are there any areas that are similar to a fluvial channel? If so, screen capture an image and paste here or have the students sketch what they see as evidence of a fluvial channel.