

Lesson 14: Mars Water World

Summary

It is hypothesized that an ocean might have existed on Mars. Students will learn what sedimentary structures and landforms in ancient, Earth, marine environments look like and the processes that formed them. From this Earth-analog approach students will observe Mars imagery and determine whether or not a Mars ocean might have existed in the distant past.

Learning Goals

Students will be able to:

- Identify spits on Mars and Earth and understand their formation.
- Recognize and identify carbonate rocks and the reasons for a lack of carbonates on Mars.
- Critically analyze press releases of Mars discoveries and determine what other data, if any, is needed to make the scientific findings valid.

Context for Use

This learning module is meant for adaptation in an introductory Earth science course and/or planetary science course. The *In-Class Activities* can be easily adapted for homework when desired.

Description and Teaching Materials

In-Class Activity

In-Class Activity 1: Spits on Mars

In-Class Activity 2: Where is the carbonate on Mars?

Homework/Lab

Homework 1: Mars Ocean Press Release

Teaching Notes and Tips

1. *In-Class Activity 2*: for classes >20 students we recommend passing around several specimens of carbonate rocks and/or use an overhead microscope system for the classroom so students can observe

the texture and make observations of the carbonate rocks without a hand specimen.

2. *Homework 1*: You may need to exchange the press release articles for more current articles depending on the year in which you use this material.
3. You will often integrate the Explanation and Exploration sections of the In-Class Activities. Interact with the students as they “explore” and help them define terms/principles.

Assessment

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

Mars for Earthlings

Resources

1. Image File: [Water World](#).
2. Spit Formation in the UK and longshore drift:
http://www.youtube.com/watch?v=Fe9YBuK_qEo&feature=endscreen&NR=1
3. Lake Bonneville video: <http://www.youtube.com/watch?v=0SJDOluY4OI>
4. NASA Video “Keeping up with Carbon”:
<http://www.youtube.com/watch?v=FgEZpX3n5mo>
5. Beachy Head geology: http://www.discoveringfossils.co.uk/beachy_head_fossils.htm



Mars for Earthlings

In-Class Activity 1

Water World_MFE

Spits on Mars

Purpose:

- Understand the concept of longshore drift and the geomorphic features it creates/develops.
- Search for and identify sand spits/tombolos on Mars

Preparation:

1. Have an Internet connection in classroom.
2. Prepare MOLA colorized elevation maps if desired (see *Exploration*)

Resources:

Spit Formation in the UK and longshore drift:

http://www.youtube.com/watch?v=Fe9YBuK_qEo&feature=endscreen&NR=1

Engage

Have students view the following video of Spit Formation in the UK and consider the following questions:

http://www.youtube.com/watch?v=Fe9YBuK_qEo&feature=endscreen&NR=1

1. On the beach, where would the coarsest of grain sizes be deposited (nearest the ocean or nearer the land; proximal/distal)?
2. What determines the location of particular grain sizes?
3. What governs the growth of a spit?

Explore

Using a MOLA colorized elevation map, have students do the following (students may come up to the screen and point, or students can annotate a map):

1. Mark or point to areas on Mars where spits could be present.
2. How did they make their decisions?
3. If longshore drift was present in the students' chosen regions, what direction is the longshore drift heading?

Explain

Longshore drift- caused by wave and current action. It is the primary method of sediment transport along the beach. The direction of this motion is always parallel to the beach face. This USGS website gives a description of longshore motion parallel to the beach face.

<http://geomaps.wr.usgs.gov/parks/sea/beach3.html>

Here is another short movie on longshore drift, but it does not explain that the return flow back to the ocean takes a pathway directly perpendicular to the shoreface (the shortest distance back under the influence of gravity).

<http://www.youtube.com/watch?v=rCpZYIPqn6E>



Mars for Earthlings

Elaborate

1. What do deposits of longshore drifts look like in cross-section? **Note: Have students hypothesize or draw a stratigraphic section. Provide guidance for the stratigraphic section.*
2. What determines the size of grains that are deposited?

Evaluate

1. Students should be able to understand and use geomorphological evidence to determine if any area had a prolonged shoreline during a period in its history (This understanding will be utilized in subsequent activities).



Mars for Earthlings

In-Class Activity 2

Water World_MFE

Where is the carbonate on Mars?

Purpose: Expose students to the carbon cycle on Earth and how carbonate rocks are created. Students will develop a line of evidence or explanation for the reasons why carbonate rocks are not abundant on Mars.

Preparation

1. Depending on your mode of delivery (in class versus perhaps a homework setting), load the Image File .ppt for the class and make sure you have an Internet connection to view the associated videos.
2. Find 3 specimens of carbonate rocks (micrite, coquina, grainstone/packstone, or chalk) or use *Image File* to show 3 specimens of carbonate rocks.
3. Have JMARS available to view carbonate minerals maps of Mars, as well as MOLA maps for geographic context.

Engage

Have students observe 3 different carbonate rocks and ask the following:

1. What are the similarities between these rocks?
2. Where might these rocks have been deposited or formed? What is the students' evidence?

Explore

Forming carbonate rocks on Earth

1. Have students brainstorm how carbonate rocks are formed. Write their ideas on the board.
2. Watch the following NASA video entitled "Keeping up with Carbon":
<http://www.youtube.com/watch?v=FgEZpX3n5mo>
 - a. How does the student's "formation" history compare/contrast with the video?
 - b. What elements of the video's content exist/do not exist on Mars?

Carbonate rocks on Mars

1. Bring up JMARS maps of carbonate rocks for students to view the extent (or lack thereof) of carbonate rocks.
2. Where are the carbonate minerals most common?

Explain

Carbonates – a class of sedimentary rocks composed primarily of carbonate minerals ranging from calcite to dolomite.

Elaborate

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Mars for Earthlings

Assign to students:

Consider the biosphere, lithosphere, and current atmospheric conditions of Mars at present, when responding to the following questions:

1. What would students need to change about Mars today for Mars to be conducive to carbonate development?

*Note: Answers can be elaborately crazy, i.e. put petroleum-powered cars on Mars and create vast amounts of CO₂ emissions or if possible move Mars closer to the sun so that it isn't so cold....etc.

Evaluate

Present the following image of Mars (for a full resolution image see the *Image File* for this module) and ask students the following questions:

In this hypothetical situation (although *real* imagery)

1. Where might the students find carbonates?
2. On what information did the students base their answers?

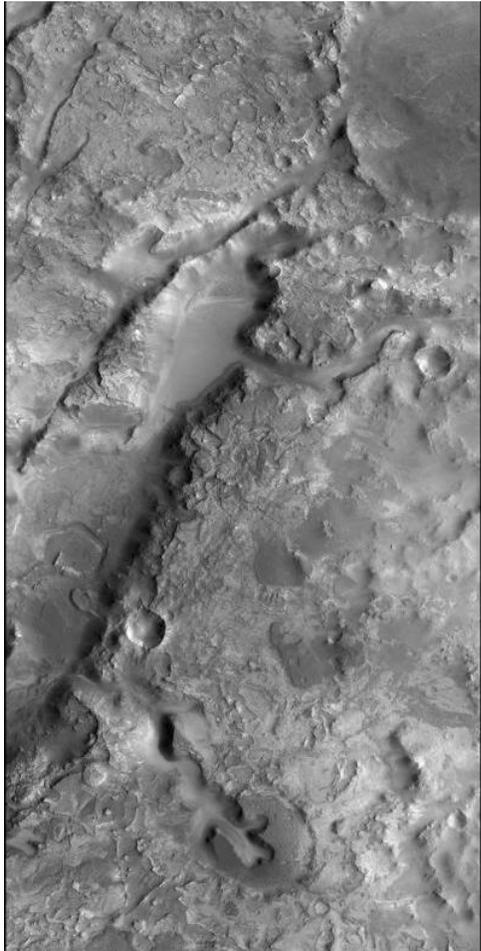


Figure 1: Nili Fossae Region Imaged by CTX, Image Credit: ASU/Malin Space Science Systems

Mars for Earthlings

Homework 1

Water World_MFE

Mars Ocean Press Release

Purpose:

Critically assess the validity of media-released discoveries of Mars; in this case, a Mars ocean.

Directions/Questions:

Navigate to the following press release by CU-Boulder in June 2010:

<http://www.colorado.edu/news/releases/2010/06/13/new-cu-boulder-study-indicates-ancient-ocean-may-have-covered-one-third>

1. What evidence does the article use to support an ancient Mars ocean?
2. In what geologic age of Mars' history would oceans most likely have existed? (Noachian, Hesperian or Amazonian) *Note: The students may need to do some outside research to answer this question.
3. What evidence would convince them that an ocean existed on Mars that this press release did not address?
4. How would they improve the press release overall?
5. Contrast the Science Daily press-release with CU-Boulder's press release. Do they differ? If so, how? <http://www.sciencedaily.com/releases/2010/06/100613181245.htm>
6. Find a more recent article on the potential Mars Ocean. Summarize the major points. Has scientists' thinking on the topic changed?

Evaluate:

After students turn in this assignment, have students discuss these answers in class, time permitting. It is important for students to discern fact (clear observations) from fiction (interpretations from incomplete evidence or wishful thinking) and recognize a properly-executed scientific inquiry.

