Lesson 4: Remote Sensing Mars

Summary
This learning module and related laboratory exercise exposes students to remote sensing techniques utilized on Mars.

Learning Goals

Students will be able to:
- Apply the concepts of scale and context in remote sensing imagery.
- View THEMIS and HiRISE images and interpret major geomorphic features using Google Mars and associated homework activities.
- Understand how MOLA generates its image data by applying the fundamental equations in an experiment.

Context for Use
This learning module is meant for adaptation in an introductory earth science course and/or planetary science course. It is advised that the teacher compare Earth-based remote sensing instrumentation for context/reference such as LandSat 7.

Description and Teaching Materials
In-Class Activity
In-Class Activity 1: Scale and Context
In-Class Activity 2: MOLA simulation
Homework/Lab
Homework 1: Google Mars-Following Opportunity
Homework 2: Mars Image Analysis

Teaching Notes and Tips
1. The *In-Class Activities* can be utilized as homework as well. Students will have a lab-write up associated with the *MOLA simulation*.
2. For a large class size >20 you may either have a separate lab time/class for different sections or demonstrate the lab with the entire class and employ student participation.
3. We advise instructors to compare Earth-based remote sensing packages such as Landsat 7 for context.
4. In preparation for the MOLA simulation *In-Class Activity* instructors must gather a few materials (see the *MOLA simulation* for further clarification).

Assessment
- The *MOLA simulation* Lab write-up will assess the student's understanding of the MOLA instrument and MOLA's utility.
- The *Google Mars* homework will assess whether or not students can successfully navigate the Google Mars software and begin to interpret the data provided by Google Mars.

THE UNIVERSITY OF UTAH®

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

Mars for Earthlings

References and Resources

1. THEMIS images url: http://themis.asu.edu/
2. LANDSAT 7 images url: http://landsat.gsfc.nasa.gov/images/
3. HiRISE 13 April 2011 YouTube video: http://www.youtube.com/watch?v=-U6-uYDtuSg
4. MRO/HiRISE All HiClips revisited (Feb 2012) YouTube Video: http://www.youtube.com/watch?v=YVDUQjJbjyc
5. MOLA images url: http://mola.gsfc.nasa.gov/index.html
6. Ping-Pong Lab (NASA): http://mola.gsfc.nasa.gov/pingpong.html

Mars for Earthlings

In-Class Activity 1
Remote Sensing Mars_MFE
Scale and Context

Purpose: Recognize the purpose and need for understanding the scale and context of various remote sensing imaging techniques.

Preparation: Print images (or share in .ppt, see *Image File*) without their captions.

Images:

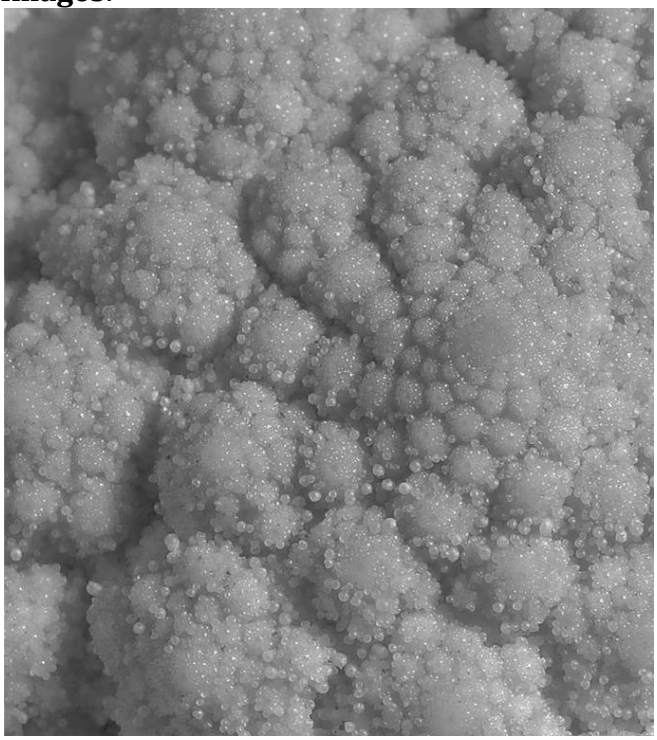

Figure 1: Close-up of broccoli romanesco
Image credit: Petr Kratochvil, public domain.

Context Image

Mars for Earthlings

Context Image

Figure 2: Close-up of a pine cone. **Image credit: Petr Kratochvil, public domain**

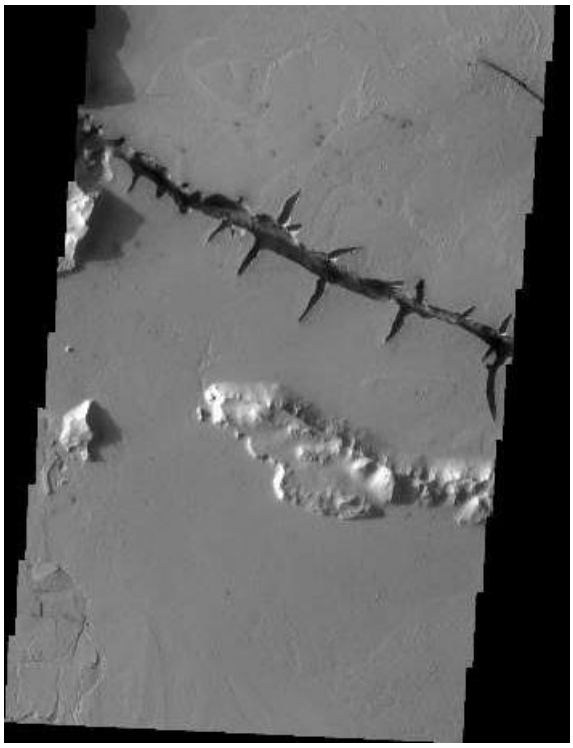

Figure 3 THEMIS Image #V13300013, Image width: 25km; Lat 7.3/Long 161.3. Image credit: NASA/JPL/ASU; Image Source: http://themis.asu.edu/zoom-20050225a

Mars for Earthlings

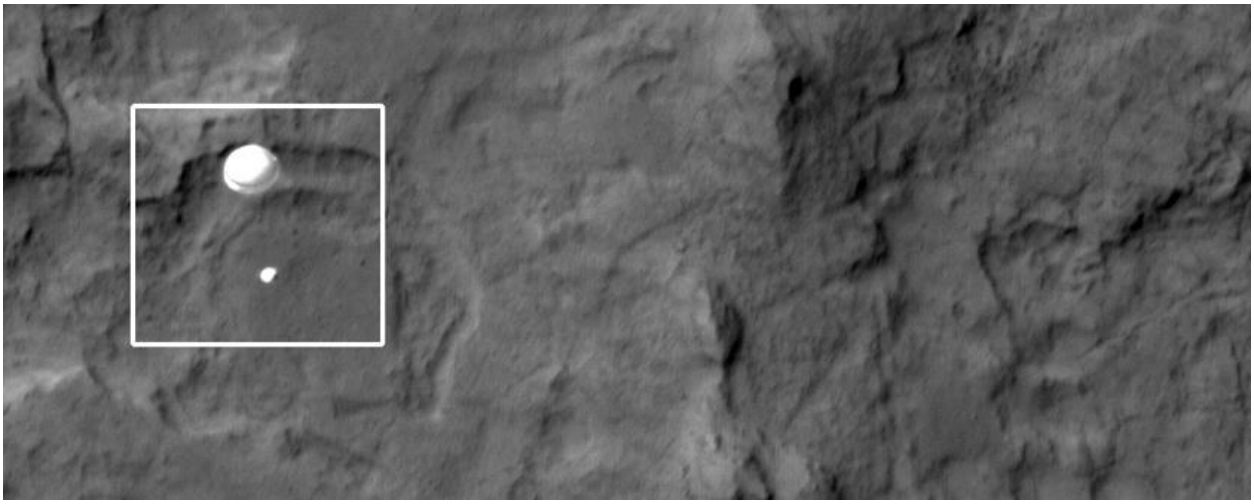

Figure 4: HiRISE image (ESP_028256_9022) of Curiosity descending to the Martian surface acquired August 5, 2012. Scale = 33.6 cm/pixel; Image Source: http://hirise.lpl.arizona.edu/releases/msl-descent.php

Engage

Referring to Figures 1-2 ask students to:

1. Hypothesize what is pictured in Figure 1 & 2.
2. Describe the basis for their hypothesis.
3. List at least (4) ideas for gathering other information that could aid in determining what the image is exactly. Explain their reasoning for their choices.

Explore

Time to apply these terms for images of Mars

1. Have students interpret Figures 1 & 2. Then, define terms of scale and context, and apply knowledge to Mars imagery.
2. Encourage students to interpret Figure 3 & 4. Provide students with the scale and context for the images (given in this version in the image caption).
3. Ask students to discuss whether or not knowing the *scale* and *context* of the images has aided them in interpretation.

Explain

1. Discuss and determine definitions of the terms *scale* and *context*.
2. Reveal the identity of the objects shown in Figure 1 & 2 (knowing what these are given in the image captions, the scales of these are small - cm to mm).
3. Ask students to provide a *scale* and *context* for each image.

Mars for Earthlings

Elaborate

1. Time permitting, have students explore mission websites such as THEMIS (http://themis.asu.edu) or HiRISE (http://hirise.lpl.arizona.edu)
2. Have them choose an image that interests them. What caught their interest? What features do they see?
3. Can they find the scale and context of the image? After knowing the scale and context, does their interpretation of the image change?

Evaluate

1. Evaluate student responses as they interpret the images. Each student should select an image and submit an explanation of the scale and context for evaluation.
   Do students have a clear understanding of scale and context as indicated by their answers in the ***Elaboration*** section?