Mars for Earthlings

LESSON 16: Weathering & Patterned Ground

In-Class Activity 1

Break a Rock!

Purpose:

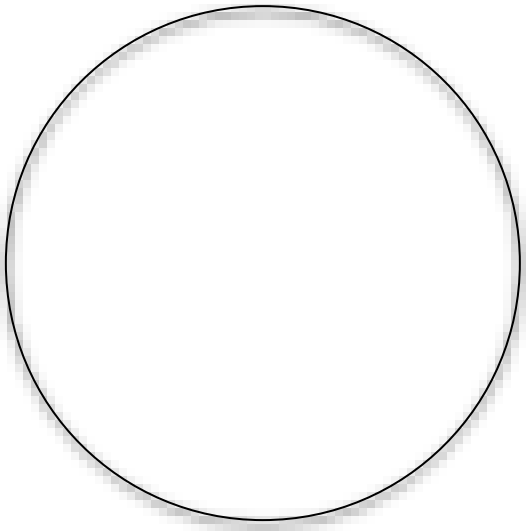
Determine how the physical breakdown of rocks leads to increased rates of weathering and erosion.

Break a Rock!

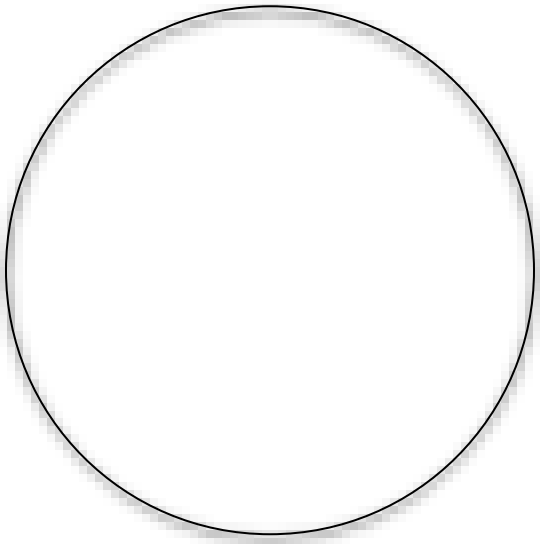
Use the rock hammer and rock provided by your instructor. Break the rock in such a manner that you can see "the middle" of the rock.

Outside vs. Inside

Make a sketch in each circle below of the outside vs. inside of the rock. Note color changes, sizes of crystals, any mottling, etc. Be as observant as possible. Provide some sort of scale to understand the relative sizes of your sketches.



Outside
Scale:



Inside
Scale:

Mechanical vs. Chemical Weathering

List any evidence for mechanical weathering and/or chemical weathering.

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The smaller the better?

1. Do you think smaller features will experience higher rates of weathering? Why or why not? What determines the "rate"?
2. Considering Figure 1, would the concept "the smaller the better" apply here? Why or why not? Note the scale in the caption.

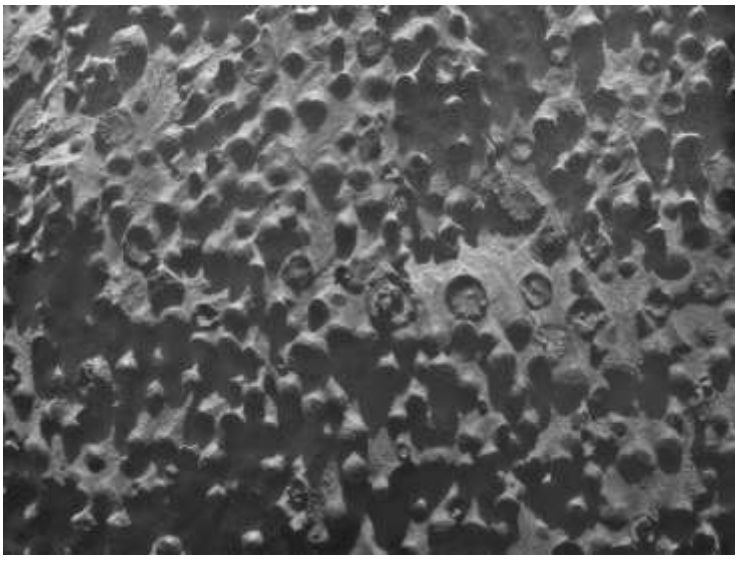

Figure 1: Image taken by rover Odyssey at Endeavor Crater: The view covers an area about 2.4 inches (6 centimeters) across, at an outcrop called "Kirkwood" in the Cape York segment of the western rim of Endeavour Crater. The individual spherules are up to about one-eighth inch (3 millimeters) in diameter. Image Credit: NASA/JPL-Caltech/Cornell Univ./ USGS/Modesto Junior College

To sum it all up…

List the three most important factors that determine the rate of weathering.

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In-Class Activity 2
Weathering & Soils_MFE
Soils on Mars?

Purpose: Identify Earth soil horizons and extrapolate what characteristics of soil would be observable on Mars.

Is it a soil?
Study Figure 1 below (or the image provided by your instructor).

1. Does this picture represent a complete soil profile? If not, what horizons are present?

2. What criterion are you using to define a soil?

Figure 1: A Russian Chernozem (Mollisols in most cases) and the landscape NW of Kursk, in the Kursk Oblast, Russia.
Source: http://web.utk.edu/~ammonst/research.html

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What makes a soil*?*

1. Brainstorm at least 4 factors that would create a soil.
    a. Factor 1:
    b. Factor 2:
    c. Factor 3:
    d. Factor 4:

2. Which factor is the most influential?

3. After discussing the 5 soil forming factors with your instructor, determine which factors exist and/or have the greatest influence on Mars. List and describe below.

Identifying Soil Horizons

In Figure 2, draw lines and/or labels at horizon boundaries. Are any horizons absent?

- Horizon- thick organic-rich layer
- A Horizon- relatively thin organic layer with rooting
- E Horizon- leached layer (not always present)
- B Horizon- mineral layer
- C Horizon- parent material

Figure 2: Image Credit: NRCS Soils

4. What characteristics of this profile might you observe on Mars? Can you observe it remotely? What do you think gives the yellow layer its color?

Mawrth Vallis

Observe Figure 3 of Mars at Mawrth Vallis, one of the landing site considerations of MSL Curiosity (captured via JMARS):

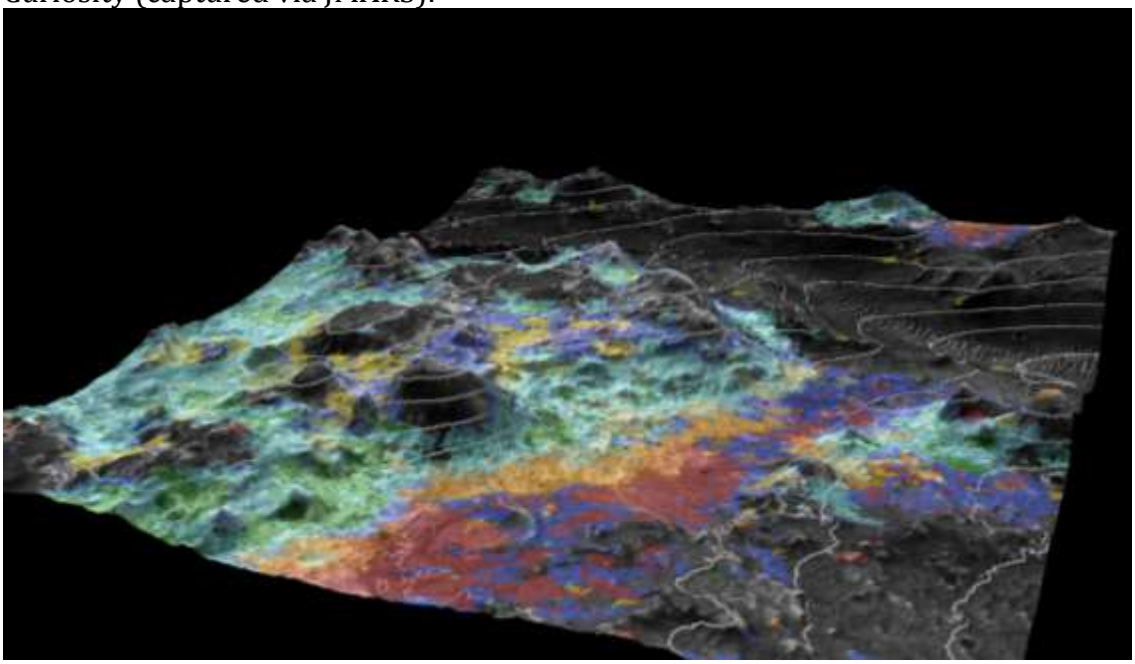

Figure 3: Mawrth Vallis CRISM image overlain on HiRISE imagery. Image Courtesy of Briony Horgan, ASU.

5. What do you observe in this image?

6. Do changes in color follow any other discernable pattern?

7. How would you recognize soils on Mars? What would be your criteria?

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Homework 1
Weathering and Soils_MFE
Chemical vs. Mechanical

Introduction: This exercise will focus on your ability to identify weathering processes/features on Earth and on Mars. The last part of this exercise will involve using Google Mars to recognize weathering features through high-resolution images.

PART I—Weathering of Earth

For the following 4 images, determine whether they are the result of mechanical or chemical weathering, and identify the specific process that formed the weathering feature.

Sandstone
Australia
Humid continental

Image 1 (Image Source: http://commons.wikimedia.org/wiki/File:Cracked_boulder_DMCR.jpg, "Devil's Marbles" Author: Prince Roy)

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Sandstone
Oregon,
Coastal/temperate

Image 2 (Image Source: http://www.earthscienceworld.org/images/search/results.html?Category=&Continent=&ImageID=hhrhsr#null Photographer: Marli Miller, University of Oregon)

Sandstone
Anza-Borrego Desert State Park,
California,
Semi-arid/rain shadow

Image 3 (Image Credit: Michael Szoenyi/Science Photo Library; http://www.sciencephoto.com/media/173681/enlarge)

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Granite
Enchanted Rock,
Texas
Humid Subtropical

Image 4 (Image Source http://en.wikipedia.org/wiki/File:GeologicalExfoliationOfGraniteRock.jpg)

PART II—Weathering of Mars

For the following images, identify whether the features are caused by mechanical or chemical weathering and answer the additional questions for each image.

Image 5

1. What are 3 likely processes causing the pits in the rock in the image below?
2. What does that mean for the type of environment that could have existed on Mars?
3. Name 3 geographic areas on Earth that would work as an analog to this rock.

Volcanic rock
Ares Valles region,
Pathfinder landing site

Image 5 (Image Source: http://science.ksc.nasa.gov/mars/mpf/stereo-arc.html)

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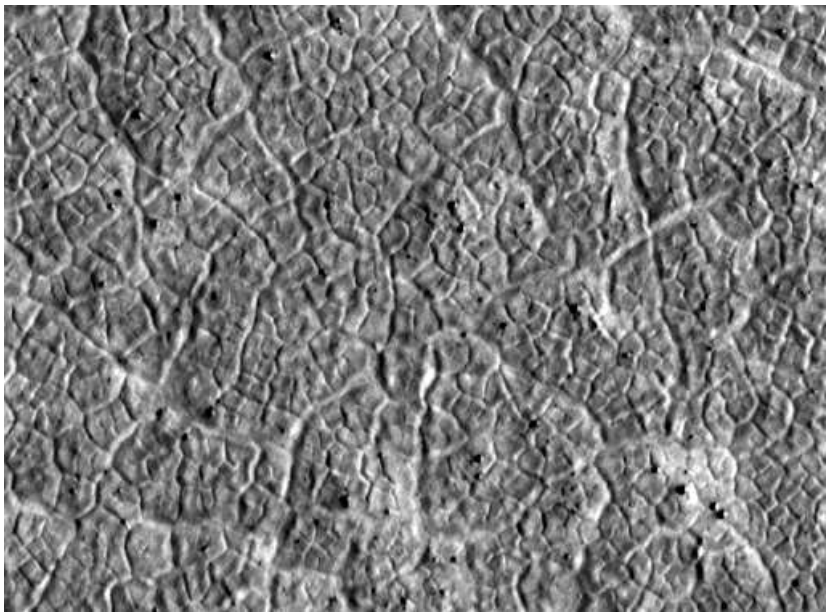
Image 6

1. What feature is shown below?
2. What are 3 processes/influences that can cause these features?



Likely sand-siltstone
Near North Pole

Image 6 (Image Source: http://web.pdx.edu/~pdx06058/Planetary_Research.html)

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Image 7

1. This is a false-color image of the surrounding area around the Sojourner Rover. What is the red tone on the Martian surface and what does that mean?

2. Which direction is the wind coming from (This does not have to do with weathering)?

Volcanic rock (Yogi rock)
Ares Valles region
Pathfinder Lander location

Image 7 (Image Source: http://nssdc.gsfc.nasa.gov/planetary/marspath_images_2.html)

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Image 8

1. What is the nickname given to the little balls scattered in the image below?

2. What are they? How are they formed and what does that mean for surface processes in the Martian past?

3. What weathers faster: the host rock or the little balls scattered on the surface? Give some reasons to support your answer.

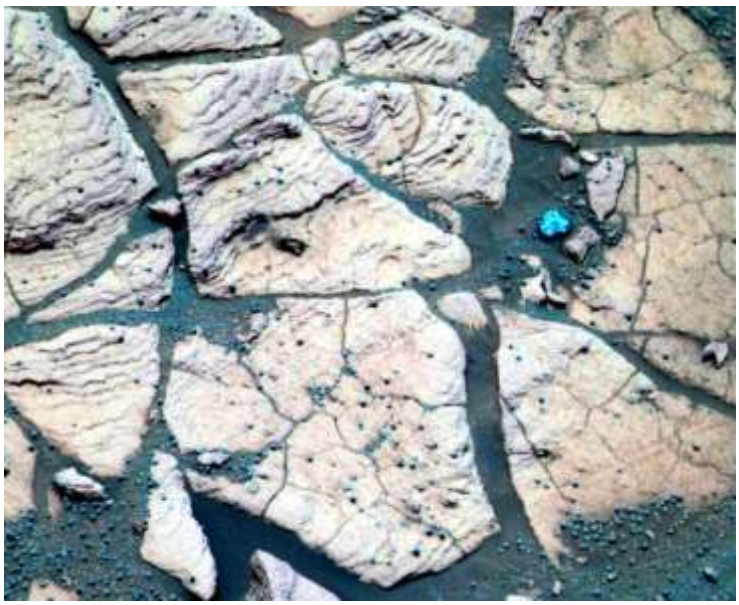

Photo by MER Opportunity Rover At rock outcrop "Shoemaker's Patio"

Image 8 (Image Credit: NASA/JPL; Source: http://photojournal.jpl.nasa.gov/catalog/PIA05584)

PART III—Google Mars

1) The images in questions 1 and 3 were taken by the Mars Pathfinder Lander.
   a. Where is the lander located (lat/long)?
   b. Go into the "presidential" panorama and describe the image and features that you see.
   c. It landed in Ares Valles. Describe the area in terms of the geomorphic features and why it presently looks this way.

2) The image in question 2 was taken by the HiRISE camera aboard the Mars Reconnaissance Orbiter. The coordinates are approximately 71° 38' N and 145° 20' E.
   a. What kind of environment would create a surface like this? Is this process continuing today on Mars? Is it continuing on Earth?

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3) The MER Opportunity rover took the image 8. Go to the following website: http://mars.nasa.gov/mer/home/
   Click on Multimedia
   - Click on images
   - Go to All Raw images for the Opportunity Rover
   - Next go down to Science Cameras/Panoramic Camera and scroll down to Sol 109, Click "View Selected Images"
   - Scroll down and explore images 8-20 under Sub-Frame EDR (not numbered)

   a. Determine why it took so many images of the same spot on the surface.
   b. Record the Sol from the latest image (go back one page). How does this Sol compare to the expected life of the mission?

   c. Go back to Google Mars and determine approximately where the rover was when it took these pictures, both geographically and lat/long.

   d. Go to the panoramic, "Crater of Clues" and briefly describe what you see, both around the rim of the crater as well as within the crater.