Rock It Out with Areology

Lesson 6

Lesson Reference: The activity is from NASA's Mars Areology lesson located in the educator guide: *Mars Activities: Teacher Resources and Classroom Activities*. The Mars Areology lesson is adapted from Mission to Mars materials from the Pacific Science Center in Seattle, WA, and Adler Planetarium. It was submitted to Live from Mars by April Whitt and Amy Singel, Adler Planetarium. The Teacher's Edition was created by ASU Mars K-12 Education Outreach Program. The complete curriculum guide is available at http://mars.jpl.nasa.gov/classroom/pdfs/MSIP-MarsActivities.pdf.

Objectives:

- Students will discover how surface core samples can tell us about the history and make-up of a planet.
- Students will examine a simulated Martian surface core sample.
- Students will learn how an unknown core sample can be identified by matching it with a known sample.
- Students will record observations, compare and contrast, develop hypotheses, and draw conclusions.

National Science Standards:

- Science as Inquiry
- Physical Science
  - Properties and changes of properties in matter
  - Motions and forces
  - Transfer of energy
- Science and Technology
  - Abilities of technological design
  - Understandings about science and technology
- History and Nature of Science
  - Science as a human endeavor

Source: http://www.nasa.gov/audience/forstudents/9-12/features/F_Practice_Makes_Perfect_prt.htm

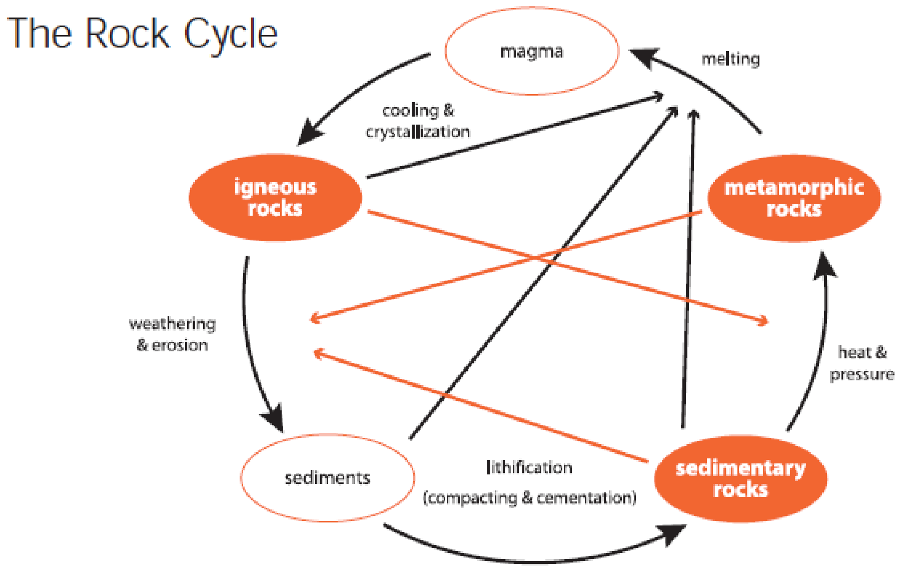
Background Information:

(from http://www.nps.gov/shen/forteachers/upload/edu_steward_geology_rocks.pdf)

The Earth is undergoing continuous change through the formation, weathering, erosion, and reformation of rock. This process is called the rock cycle. There are three main types of rocks: igneous, sedimentary, and metamorphic. Rock deep within Earth encounters temperatures high enough to make it melt. This liquid stage is called magma. Igneous rock is formed when the magma cools and solidifies. Magma that is forced to the surface cools to form volcanic rock, while magma that cools beneath the Earth's surface forms granitic rock.

As rocks are weathered (broken down into smaller pieces) and eroded (moved to new locations), the rock fragments (sediments) build up in layers. The combined weight of the layers along with other pressures within the Earth causes the layers to compact. The tiny spaces between rock fragments fill with natural cementing agents and mineral grains in the rock may grow and interlock. Thus sedimentary rock has been formed. Sedimentary rock is also formed under water when shells and skeletons of sea creatures accumulate on the ocean floor. Over a long period of time, these sediments compact and harden to form rock. Fossils are most often found in sedimentary rock.

Sedimentary rocks and igneous rocks can be altered by the tremendous pressures and high temperatures associated with the movement and collision of tectonic plates. Metamorphic rock is formed under these extreme conditions. Ultimately, any of the rock types may again return to a hot, molten state deep in the Earth, thus completing the rock cycle.



Source: U.S. National Park Service
http://www.nps.gov/shen/forteachers/upload/edu_steward_geology_rocks.pdf

Studying geology helps people to understand how today's geological formations were created and to predict future changes. The consequences of natural events and human activity can be better analyzed with knowledge of the underlying rock formations. Geologists often take a "core sample" by drilling into a rock formation and pulling out a layered specimen of the rocks to determine a timeline of geologic events for that area.

Materials:

- An assortment of "fun" or "bite/snack size" candy bars
- Copies of Areology: The Study of Mars (one per student)
- Activity materials (per pair of students):
  - 1 small candy bar
  - 2 pieces of a clear plastic soda straw (about 3" long each)
  - Paper plate (or napkin)
  - Plastic knife
  - Graph paper or small ruler
- Wet wipes (optional for hand clean-up prior to activity, since edible material is involved)

Advance Lesson Preparation:
Pre-cut the straw pieces.

Ensure that the candy bars are at room temperature. You may even wish to briefly place the candy bars near a sunny window to help warm them a little bit. This will make them a bit softer, which will make it easier to insert straws. Additionally, you may wish to unwrap the candy bars immediately before beginning the lesson. If you do this, be sure to use gloves when handling the candy bars.

If appropriate for your students and your grade level, consider acquiring and showing the 50-minute video "Episode 10: Galileo was Right" from the HBO mini-series *From the Earth to the Moon*. It shows the importance of science, with emphasis on geology and technology. Additionally, it reveals how both a teacher (professor) and students (astronauts) grow from their experiences working together to make scientific achievements on the Moon. Viewers will see the process of obtaining core samples from the Moon. The video does contain a few instances of mild adult language, along with adults smoking. The video is an account of part of the Apollo program in the early 1970s. It is a nice introduction to geology and the understanding that rocks will "speak" to you if you understand the language.

Lesson Presentation:

1. Provide the students with the following scenario:

   You are going to receive a Martian surface sample. (Hold up an unwrapped snack-sized candy bar.) It is your job to observe and determine all the scientific information you can from this sample. You will be taking a core sample from this Martian surface sample and answering questions. (Demonstrate how to use the straw to take a core sample. Inform students that twisting the straw back and forth as they carefully apply pressure downward onto the Martian sample may help the straw to more easily penetrate any difficult layers within the sample.)

2. Tell the students that this type of activity (obtaining and analyzing core samples) is actually performed by geologists. Geologists are scientists who study the structure and substructure of a planet, typically Earth, as the term "geo" means Earth. Briefly review the background information with the students.

3. Tell the students that, in addition to studying the Earth, there are some geologists who have actually studied core samples retrieved from the Moon. Additionally, some geologists have and are currently studying the structure of Mars, to include its rocks and landforms such as canyons, mountains, and volcanoes. (The volcanoes on Mars are not active; they are extinct.) Thanks to technology such as satellites and rovers, geologists are able to study Mars even though it is, on average, about 140 million miles from Earth.

4. Assign or allow students to select a partner. Distribute the Mars worksheet to each student and distribute the activity materials to each pair. If you are providing students with candy bars that are still inside their wrappers, emphasize that the partners should try to keep the realistic candy bar name of their Martian surface sample a secret due to the nature of this project. As soon as students unwrap their surface sample, walk by with a trash bag or container so that students may quickly and discreetly dispose of their wrappers.
5. Inform the students that at the top of their paper, they see the word "areology." Tell the students that the meaning of the term is written to the right of it; areology means "the study of Mars." Tell the students that they will follow the directions on the paper, and remind the students that each student is to complete his/her own paper (even though they are working with a partner).

   Tell the partners to raise their hands when they are ready to compare their core sample with another pair's core sample. Inform the students as to where they are supposed to meet to compare and contrast their core samples.

   If there are no questions, allow the students to begin.
6. Once students have finished, either collect the worksheets to grade or review the questions and answers as a class.

Summarization:
Review and discuss the activity with the class. Student answers will vary for most of questions on the worksheet. Select questions and potential answers have been included below as a helpful resource.

<u>Select questions from the student worksheet and potential answers:</u>

4. What is your hypothesis about the cause of any texture and/or surface features that you see?

   Although answers will vary, look for ideas such as water erosion (fluvial), wind erosion (aeolian), volcanic eruptions, earthquakes, meteor or asteroid impacts, etc.

9 – 10.

On the picture you drew of your core sample in #5, label the layers in the order in which you think they formed from youngest to oldest, with 1 representing the layer that you believe is the youngest, 2 representing the layer that you believe is the next oldest, and so on. Explain how you decided which layers were older or younger than others.

The layer at the top of the straw (the outside chocolate covering of the candy bar) would be the youngest area of deposit, and, therefore, should be labeled with the number one. The stratigraphy (the order of the layers) would grow older as they go down the straw, towards the bottom. This would generally be true, barring any unusual events, like earthquake faulting or magma (liquid rock) intrusion.

17. What would account for the samples being different, if both come from Mars?

The core samples may have been taken from different sites or different places on the planet. Remember that one sample does not necessarily translate to the whole planet being like the sample. (A good childhood story of which to remind the students is the "The Blind Men and the Elephant" where the blind men all feel a different part of the elephant and think they know what the whole elephant is like).

18. Why would a core sample from Mars be important to the study of Mars?

Most of our science observations have been of surface features. To have a better understanding of the processes that formed the Martian features, probing the subsurface would be very important. There are also many unanswered questions the scientists are trying to find answers for: Is there water in the subsurface (perhaps that a human mission to Mars could access)? How many layers are there and how thick are the layers in the subsurface? Are there different rocks underground than there are on the surface of Mars?

19. Is it better to study a Martian core sample in a lab on Earth or in a lab on Mars? Why?

Actually, a case could be made for both sites. Earth would probably have better, more sensitive science equipment available since spacecraft equipment is somewhat limited due to space/cost/sensitivity factors. Studying the sample on Mars would allow the scientist to observe the actual site and surroundings of the core sample. Was this sample typical of the rest of the terrain, or an unusual occurrence? A field study could be better conducted on Mars.

Finally, in wrapping up this lesson, ask the class how this activity relates to the Earth. (Refer to the background information.)

Career Connection:
(from http://climate2.jpl.nasa.gov/eswSite/eswCareers/#geologists, http://quest.arc.nasa.gov/people/cfs/generic/geomorphologist_150.pdf)

Geologist - Geologists study Earth materials, processes and history. They make ground-based observations of the changes Earth undergoes. Geologists study the dynamic forces that shape our Earth and use this knowledge to predict how those forces will affect mankind. Geologists might study earthquakes, volcanoes, soil erosion, or water.

Geologists, begin their careers with a bachelor's degree in geology, geochemistry, geophysics or a related science. A strong background in math, science and geography is necessary. You may need a master's or Ph.D. for advanced geology. Project managers and consultants may also be expected to have further education, and possibly, business administration courses. Part-time field work may be available after the first year of college.

Geomorphologist - Geomorphologists study the surface features of a planet and the processes that created them. The landforms and landscapes they study may be as small as a landslide or as large as an entire planet! They work to figure the ways that landforms, regions, and planets are changed by climate, and by geologic processes such as the wearing away of rock by wind, water and ice, or chemicals. They study these changes over periods of time that range from days to millions, even billions, of years. Related job titles include: geologist, geological scientist, geoscientist, and Earth scientist.

Geomorphologists begin their careers with a bachelor's degree in geology, geochemistry, geophysics or a related science. A strong background in math, science, and geography is necessary. One may need a master's or Ph.D. for advanced geology research. Project managers and consultants may also be expected to have further education, and possibly, business administration courses. Part-time fieldwork and laboratory work during college is highly recommended to gain hands-on experience.

Evaluation:

- Teacher observation
- Areology: The Study of Mars worksheet

Lesson Enrichment/Extension:

- Engage students in a similar core-drilling activity to determine the ages of sedimentary rock layers. A fully detailed lesson plan that includes a worksheet is available at http://www.windows2universe.org/teacher_resources/teach_strata.html.
- Select from a number of rock-related activities at http://www.nps.gov/shen/forteachers/upload/edu_steward_geology_rocks.pdf.
- Have students learn rocks using the interactive rock cycle pages at http://www.learner.org/interactives/rockcycle/.
- Obtain lyrics to the rock cycle song at http://cmase.uark.edu/teacher/workshops/GEMS-lessons/Rock_Cycle_Song.pdf and teach it to your students. It is sung to the tune of Row, Row, Row Your Boat. Have them sing it karaoke-style by playing the music and video at http://www.youtube.com/watch?v=F5YSedeq6i0.

Associated Websites:

- What is Geology? What Does a Geologist Do? (article)
  http://geology.com/articles/what-is-geology.shtml
- Geology information
  http://kids.earth.nasa.gov/archive/career/geologist.html
- Rock cycle
  http://www.mineralogy4kids.org/rockcycle/rockcycle.html (student friendly)
- Rock classification
  http://scienceviews.com/geology/rockclassificationchart.html
  http://www.rockhounds.com/rockshop/rockkey/

AREOLOGY: THE STUDY OF MARS

Name______________________________ **Partner** ______________________________

Directions: You have just received a Martian surface sample. It is your job to observe and determine all the scientific information you can from this sample. Follow the directions below.

1. Describe the color of your Mars sample. ____

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2. Draw a picture of your Mars sample. Be sure to include any surface features (smooth, wavy, lined, bumpy, cracked, etc.) you see.

3. Describe the surface features of your Mars sample.

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4. What is your hypothesis about the cause of any texture and/or surface features that you see?

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5. Use the drill (straw) to take a core sample from your Martian surface sample. Draw a picture showing the layers of your core sample. Show the thickness of each layer in your drawing.

6. How many layers does your Martian core sample contain? ____________

7. Describe the characteristics of each layer. ____

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8. Are any layers repeated? ______ If so, which layers are repeated? ____________________

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9. On the picture you drew of your core sample in #5, label the layers in the order in which you think they formed from youngest to oldest, with 1 representing the layer that you believe is the youngest, 2 representing the layer that you believe is the next oldest, and so on.

Adapted from Areology: The Study of Mars data sheet located at http://solarsystem.jpl.nasa.gov/docs/Areology_Mars.pdf

10. Explain how you decided which layers were older or younger than others. ________________

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11. Use the saw (plastic knife) to cut your Martian surface sample in half to view the layers easily in a cross section. Draw a picture of the inside of your Martian surface sample.

12. Do you notice any difference between the layers revealed in your core sample and the layers you see while viewing the cross section of your surface sample? If so, describe the differences.

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13. Obtain a different *core sample* from another group of scientists (pair of students). Draw a picture of the second core sample showing any layers and surface features.

14. List any similarities or differences between your first core sample and the second sample.

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15. What would account for the samples being different, if both come from Mars?

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16. Why would a core sample from Mars be important to the study of Mars? ___________________

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17. Is it better to study a Martian core sample in a lab on Earth or in a lab on Mars? Why?

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