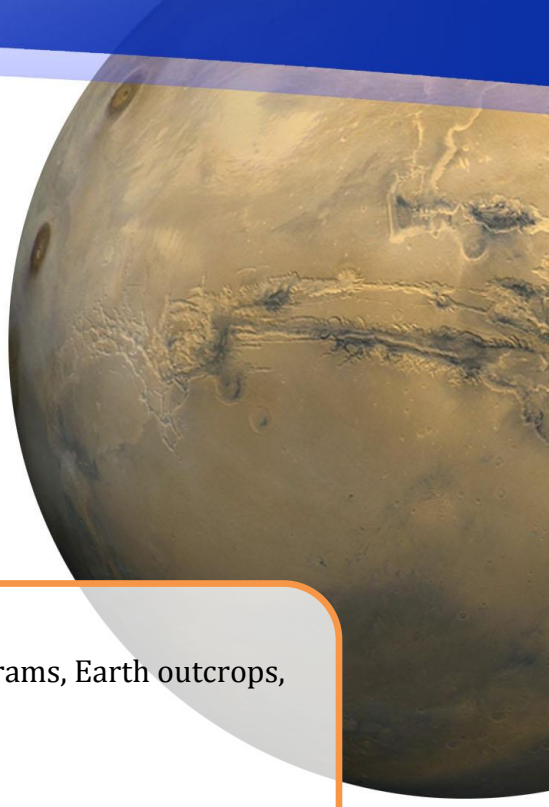

Lesson 11: Age & Times of Mars vs. Earth

Summary
This learning module discusses the geologic history of the Earth, the principles scientists use to define the Earth's geologic history, and relative dating techniques.

Learning Goals

Students will be able to:

- Use principles of relative dating to interpret block diagrams, Earth outcrops, and Mars imagery.
- Compare the geologic history of Earth and Mars.
  Compare examples
  http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA16098 &
  http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA16099

Context for Use
Make sure students have a basic understanding of lithologies in addition to the method of crater counting for dating and interpreting the ages of Martian terrain.

Description and Teaching Materials
In-Class Activity
In-Class Activity 1: A Timescale Comparison
Homework/Lab
Homework 1: It's All Relative

Teaching Notes and Tips

1. Expose students to Crater Counting such that students realize the geologic timescale of Mars and that dating of the Mars surface is based upon crater counting.
2. For *Homework 1* make sure students have a basic knowledge of lithology in order to interpret unconformities.
3. Depending on class size, if possible, make copies of the geologic maps for students to use during *In-Class Activity 1*. If class sizes are larger than 30, include these maps in a course packet. Overhead projection of the maps may not be sufficient to engage fully in the activity.
4. *Homework 1* can be adapted for an in-class activity as desired.

Assessment
Methods of assessment are within each individual *In-Class Activity* and *Homework*.

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References and Resources

1. Image File: Age and Times of Mars vs. Earth
2. YouTube video of the Noachian period on Mars (artist interpretation): http://www.youtube.com/watch?v=JfYIvkTQ2pc
3. Simplified geologic map of the state of Utah: http://geology.utah.gov/maps/geomap/postcards/pdf/utgeo_postcd.pdf
4. Geologic maps of Mars: http://www.lpi.usra.edu/resources/mars_maps/1083/index.html http://pubs.usgs.gov/sim/3292/

Mars for Earthlings

In-Class Activity 1

Age & Times of Mars vs. Earth_MFE

A timescale comparison

Preparation

1. Using either the image file provided in the Age & Times of Mars vs. Earth learning module or images of your own, display the geologic timescales of Mars and Earth.
2. Have copies of both Utah geologic maps and Mars geologic maps available for students to use. See Resources & References in Age & Times of Mars vs. Earth.

Engage

Compare the geologic timescales of Earth vs. Mars and ask students the following questions:

1. What differences do the students observe in the timescales?

2. What do they think is responsible for those differences?

Explore

Have students view the following YouTube video about the Noachian period of Mars (an artist's rendition/animation of the period):
http://www.youtube.com/watch?v=JfYIvkTQ2pc

1. What do students notice about the early period of Mars?

2. How similar/dissimilar is it from Earth?

Explain

1. Due to Earth's diverse processes and its location in the habitability zone, Earth's geologic history is diverse and varied with respect to Mars.
   Note: The **habitable zone** (a.k.a. the **Goldilocks zone)** is the region around a star where planetary bodies with sufficient atmospheric pressure can support liquid water at their surface. The Kepler project specifically looks for habitable planets.
   http://www.nasa.gov/mission_pages/kepler/main/index.html#.UjJMMbwZ9ho

2. Earth's geologic history is largely defined by its faunal/fossil record, whereas Mars cannot be dated by such a method.

Mars for Earthlings

3. Mars geologic history is defined by the amount and size of craters per unit area (see *Crater Counting In-Class Activity* in learning module **Meteorites & Impact Craters**).

Elaborate

Geologic Map of Earth

View a geologic Map of the state of Utah on Earth:
http://geology.utah.gov/maps/geomap/postcards/pdf/utgeo_postcd.pdf
Note: this map is simplified

1. What is the scale of the map?

   How many degrees of latitude and longitude does the map cover?

2. Roughly how many colors are used on the map and what do they represent?

3. How old is the oldest terrain in Utah? (give "age name" and years)

   Why is there so little of this terrain?

Geologic Map of Mars

View a geologic Map of Mars:
http://www.lpi.usra.edu/resources/mars_maps/1083/index.html

1. What is the scale of the map (ratio)?

   How many degrees of latitude and longitude does the map cover?

2. What does the color scale indicate on the map and how does this differ from the Utah map?

3. How old is the oldest terrain according to the map? (give "age name")

   If this is hard to discern, why is this?

Mars for Earthlings

4. Now look at the latest map of Mars (click on map sheet) at:
http://pubs.usgs.gov/sim/3292/
Name 3 ways in which it is different from the earlier map of Mars that you looked at? (hint look at the abstract)

a.

b.

c.

Evaluate

1. Consider the difference between Mars and Earth. Ask the students why only a geologic map of Utah (and then N. America) was provided to them.

   What is the potential difficulty in providing them a geologic map of the entire Earth?

2. Notice how the shapes and geometries of colored units on Mars vs. colored units on Earth. Cite 3 ways in which the mapped geologic features of Mars are distinctive or different from Earth (comment on the implication of the processes that are different):

   a.

   b.

   c.

Mars for Earthlings

Homework 1

Age & Times of Mars vs. Earth_MFE

It's All Relative

Objective: Apply relative dating laws to interpret block diagrams, Earth road cuts, and Mars imagery.

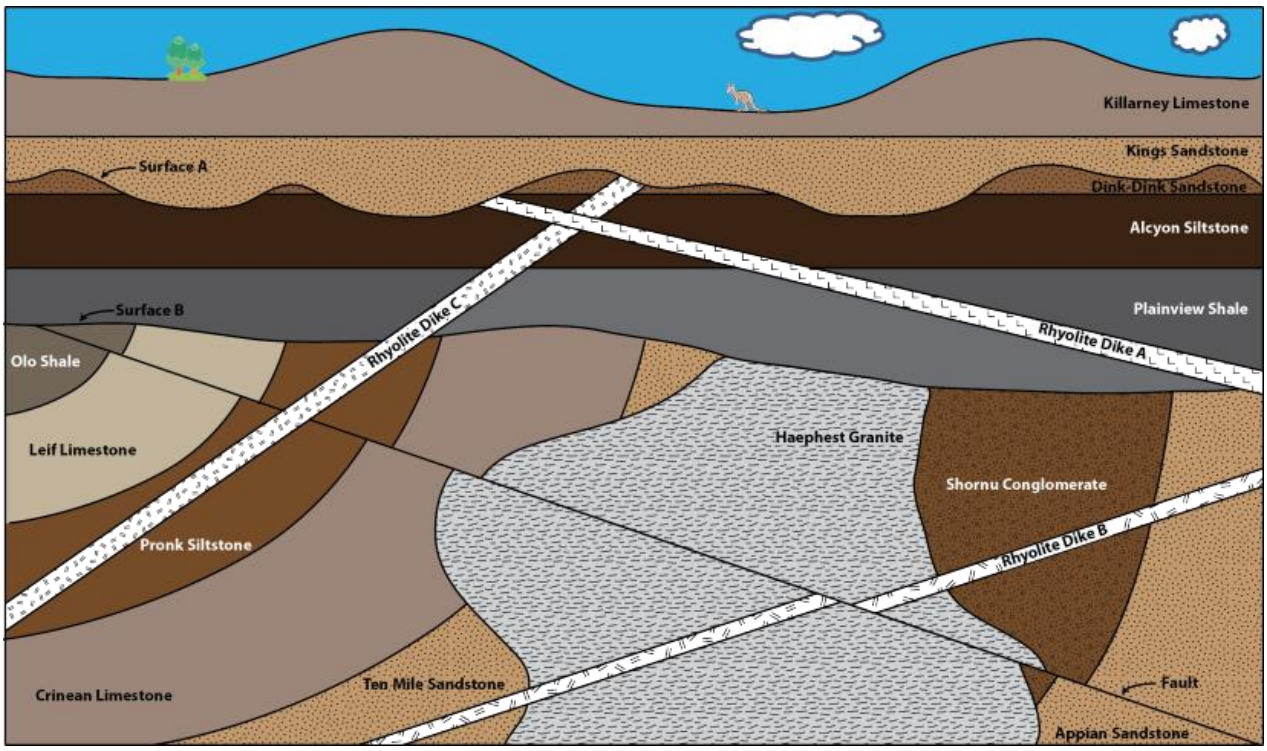

Figure 1 Block diagram. Source: http://fractalplanet.wordpress.com/2013/02/11/relative-dating-activity/

1. How many unconformities (erosional breaks) are present in the image? Name each kind and explain your reasoning.

2. What law did the students use to determine the relative ages of the Ten Mile Sandstone and Appian Sandstone?

Mars for Earthlings

3. List the order of geologic events by name from *oldest to youngest* below (i.e. Surface A, Rhyolite Dike C, Ten Mile Sandstone etc.):

Road Cuts on Earth

Navigate to the website: http://www.gigapan.com/gigapans/104247 to view the Moab Fault Zone in Utah.

4. How many faults do the students observe?

5. How many geologic units do they see? What criteria are they using to differentiate their geologic units?

6. What principle of relative dating is most useful for interpreting this image?

7. Are there any unconformities? If so, how many and what type?

Mars for Earthlings

Tractus Catena on the south of Alba Mons

Below (Figure 2) is an image taken by THEMIS of a fracture zone on Mars. Observe the image and answer the following questions:

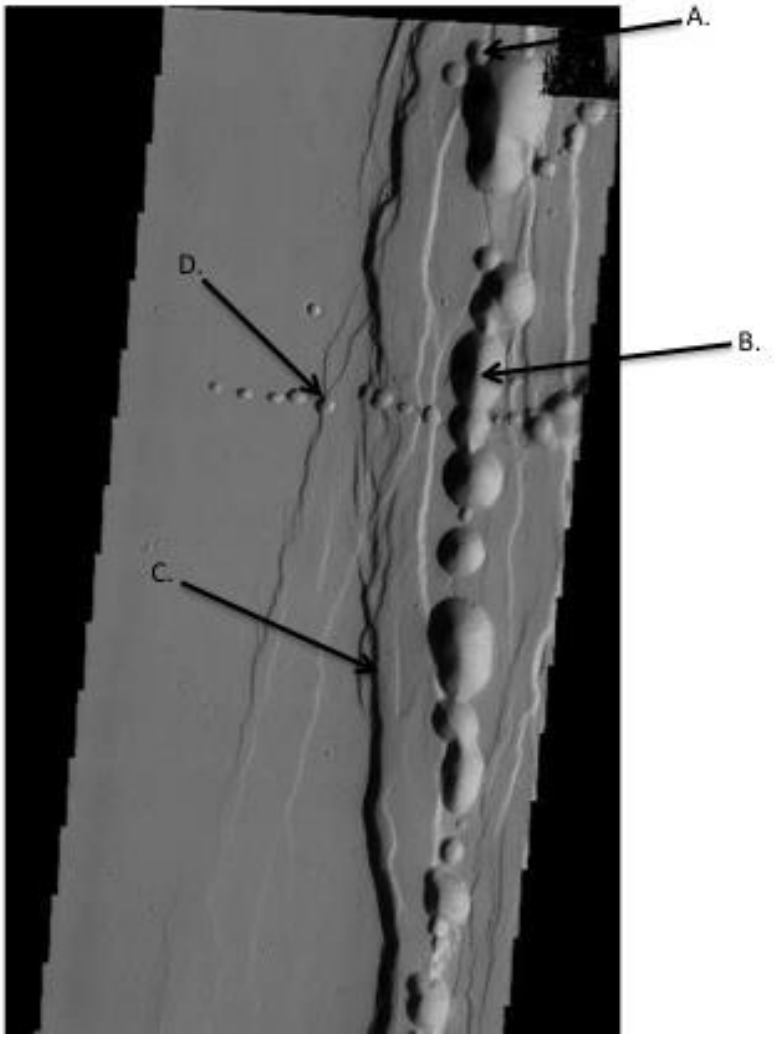

Figure 2 Tractus Catena on the south of Alba Mons, Mars. Themis image; Image Credit: NASA/JPL/ASU. Source: http://themis.asu.edu/node/5918

8. Order the geologic events (A-D) from *oldest to youngest*. Make sure the students note the entire image as you make their decisions.

9. What makes this image difficult to interpret?

10. What law(s)/principles of relative dating did they use to interpret the image?

11. If they are already familiar with tectonics, are features B and D likely related to extension or compression? Have students justify their answers.