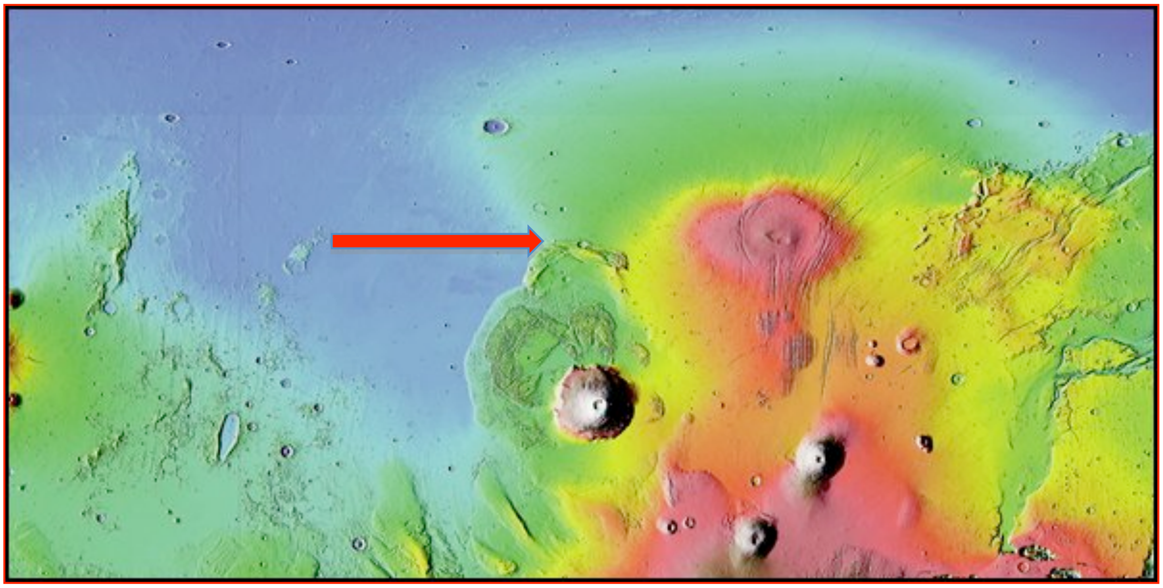
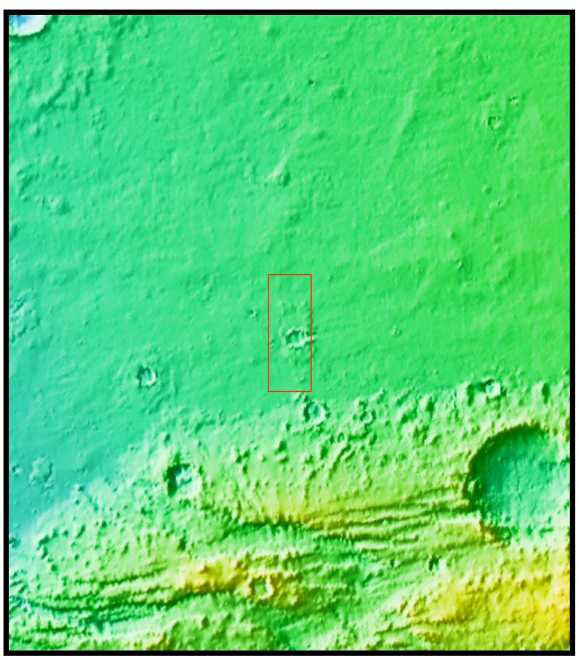
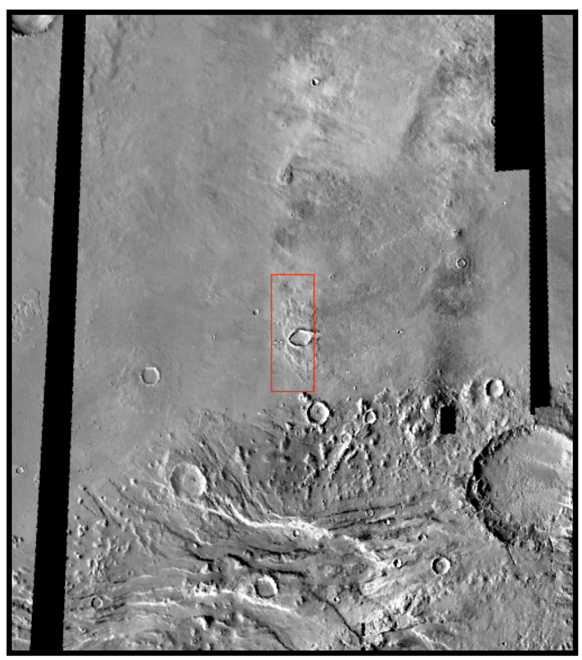
(A) What can you tell from a picture? (1 of 2)

NAME:________________________________







See Section 5.0 and Teacher Guide at the end of this lesson for details on Instructional Objective(s), Learning Outcomes, Standards, & and Rubrics.

(A) What can you tell from a picture? (2 of 2)

(B) Background

How do scientists understand and interpret the surface features of Mars from orbit and determine if a proposed landing site will meet the mission's science goals? The distance to Mars varies between 80 and 240 million kilometers (50 – 150 million miles). The planet is therefore studied using remote sensing techniques. As part of the science studies from the *Mars Global Surveyor* and *Mars Odyssey* missions, images from these spacecraft have provided valuable information that has been used to understand the surface of Mars in the context of finding and evaluating possible landing sites. The images from these orbiters have also given scientists a better understanding of the past geologic history and the present conditions on Mars. The geological processes that occur on Mars are similar to those that occur on Earth. Comparative planetology, especially between Earth and Mars, is widely used by scientists currently researching Mars. As you work through this activity, think about what you know about Earth to help you better understand the processes on Mars.

Photo Courtesy of NASA's Jet Propulsion Laboratory

For this activity, you will be using images taken with the Thermal Emission Imaging System (THEMIS) camera on-board Mars Odyssey Spacecraft orbiter (pictured above). THEMIS has taken hundreds of thousands of images of Mars that are available on the internet at http://themis.asu.edu.

THEMIS (pictured right) is a two-in-one camera system:

- Visible Imaging System
  - Shows the morphology or shape of the surface
- Infrared Imaging System
  - Can tell us the temperature of the surface (daytime and nighttime)
  - Provides information about what materials on the surface are made of
  - Daytime infrared images can also show the morphology or shape of the surface in much the same way visible images do.

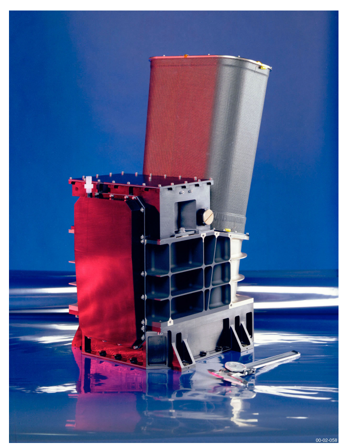


Photo Courtesy of NASA's Jet Propulsion Laboratory

(C) Lesson Background

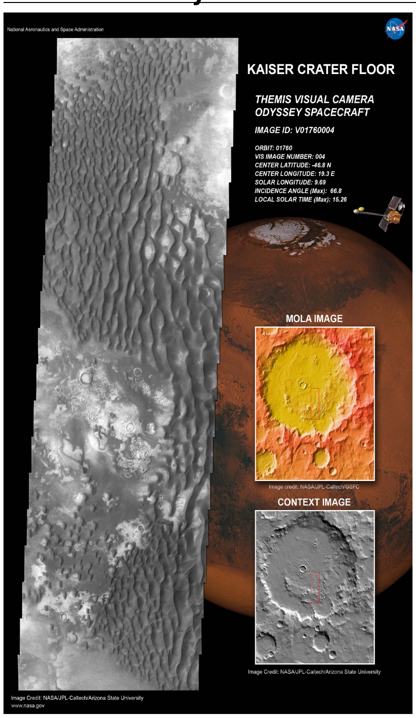
Essential Question: How do people reconstruct and date events in Earth's planetary history?

For this activity, you will be placed in the role of scientists. You will complete four different tasks as part of a guided investigation and introduction to the Mars Thermal Emission Imaging System (THEMIS) camera images. Your investigation will include:

1. Discovering what geologic features can be identified on the surface of Mars;
2. Determining the surface history of an area;
3. Calculating the size of observed features in images; and
4. Developing scientific observations.

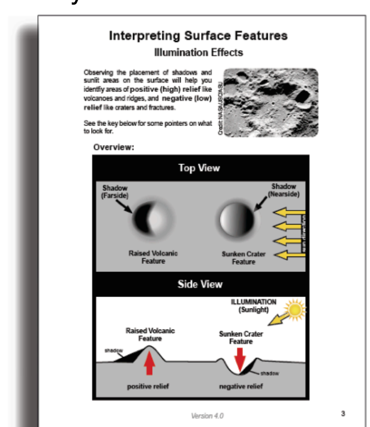
Throughout this activity, you will be completing a **Student Data Log**. A variety of tools are available to help you in this activity. Your teacher will help orient you to each of these throughout the activity.

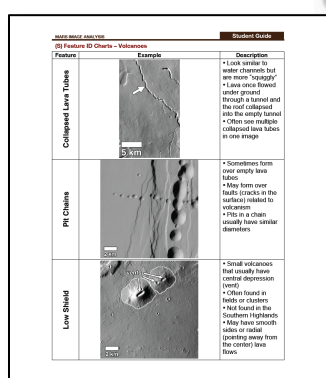
Part 1: Identify Surface Features:

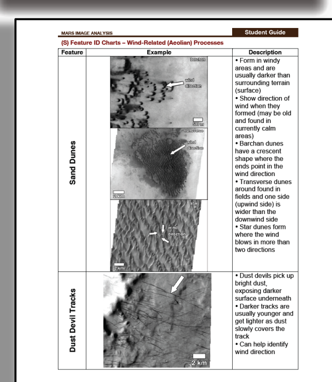


SAMPLE THEMIS IMAGE AND CONTEXT IMAGE

For this activity, you will analyze images of Mars provided by your teacher. As you observe images, be sure to use the **Feature ID Charts** to help you identify and label features with a wet erase marker. Your teacher will explain the materials and information you have available for this part of the activity and when to fill information into the **Student Data Log**. Here you will see a sample of the **THEMIS image** and **Feature ID Charts** you will be using.







(D) Student Data Log

NAME:_______________________________

Use this table to order the major (most noticeable) features according to their relative ages. The oldest feature should be numbered 1, next oldest 2, 3, 4, 5, to the youngest number 6.

Feature Name	Oldest → Youngest	Age Rank	Describe How Feature Formed

Write out a short "history" of the major events that took place in your area. Use the relative age of the features that you listed in your table.

____

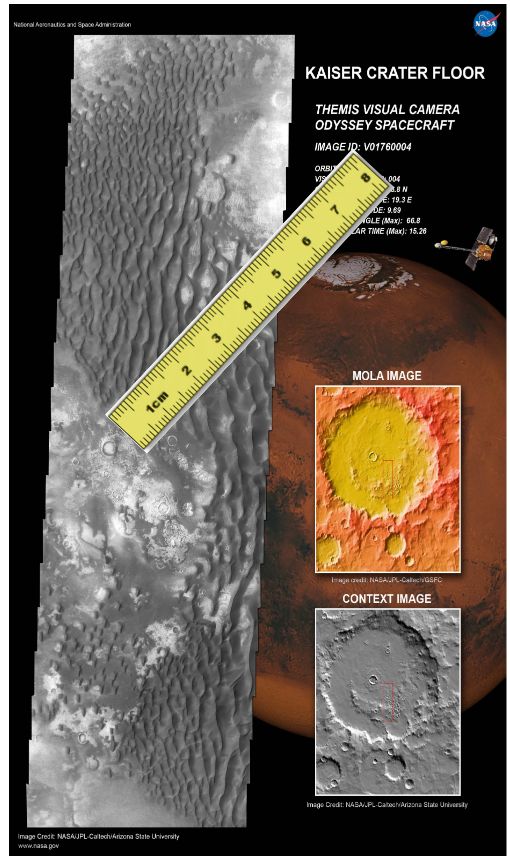
____

____

____

____

(K) Making Measurements Notes



Example:

1. **Determine the *scale factor* for your image:**
   A. Measure the distance across in centimeters: **21 cm**
   B. Divide to figure out the scale of your image:

      18 km = _**21**___cm

      18 km / _**21**__ cm = **0.86** km/cm)

      ***Scale Factor*: 1cm = 0.86 km**

2. **Multiply the size of any feature measured in centimeters by the scale factor:**

   Example: Width of channel = _**2**__cm

   _**2**__ cm X **0.86** km **=** _**1.72**_ **km**

   Width of channel = 1.72 km

**Use this page section to calculate the scale factor of your THEMIS image:
Determine the *scale factor* for ***your image***:

A. Measure the distance across in centimeters: __________cm

B. Divide to figure out the scale of your image:

18 km = __________cm

18 km / __________ cm = ____________km/cm)

***Scale Factor*: 1cm = ______________km** (Include this scale factor on your image)

**Remember, as you measure features on your image in centimeters, you will multiply that measurement by your *scale factor*. Be sure to list the *scale factor* on your image as well as the sizes of features you calculate.

Record the feature measurements into your Student Data Log sheet.

See Section 5.0 and Teacher Guide at the end of this lesson for details on Instructional Objective(s), Learning Outcomes, Standards, & and Rubrics.

(L) Student Measurement Data Log

NAME:______________________________

Use this table to record your feature measurements.

Step 1: Measure the distance across in centimeters: __________cm

Step 2: Divide to figure out the scale of your image:

18 km = __________cm

18 km / __________ cm = ___________km/cm)

***Scale Factor*: 1cm =** _______________**km** (write this number in the column title "Scale Factor")

Feature Name	Feature Measurement X	Scale Factor	= Feature Actual Size

(M) Establishing a Research Topic of Interest

NAME:________________________________

Use the next page as a guide for completing your background research. Remember, your goal is to become an expert on your topic.

1. Within your group, brainstorm four **general topic** that can be studied about Mars. For example; volcanism, cratering, water, human exploration, etc. These can be whatever interests you and your group.

   ______________________________ ______________________________

   ______________________________ ______________________________

2. As a class, vote on the topic that is most interesting for your research. Your class topic for research is: ____

Why Background Research?

Knowing a lot about your topic will help you make better observations. Better observations make better research questions.

Many of your THEMIS image observations are everyday observations. Everyday observations are very general. These observations are good, but we want to learn more about Mars. We need to look for features that are important to scientists.

Important observations make great research questions. Great research questions help scientists understand Mars and its history.

Examples:

Everyday observation:

There are many craters in the image.

Scientific observation:

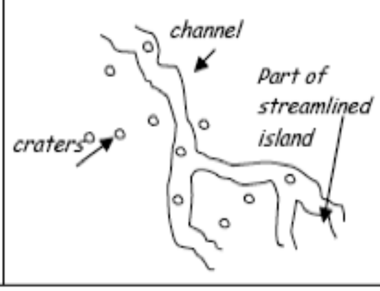
There are 20 craters in the image that are over 10km wide.
25 craters are destroyed craters.
There are 34 craters in the rocky areas, but only 2 in the flat areas.
Not all of the craters with central peak have rough walls.

(N) Background Research

NAME:________________________________

Citation (Source):		
How was the feature formed?	What are are they typically found on the Mars?	How are they similar or different from what can be found on Earth or other planetary bodies (planets/ moons?)
Drawing:	Drawing:	Drawing:

(P) Example Observation Table

Surface/Geologic Feature(s) Observed & Image ID #	Sketch of Surface/Geologic Feature(s)	Specific Observations of Surface/Geologic Feature(s)
Channel with craters **Image ID #:** V11030007		*-Channel does not seem very wide* *-Can see streamlined islands* *-Small craters both on the outside and inside of channel* *-All craters in image seem to be about the same size*

Make scientific observations:

1. Fill out the following two observation tables.
2. Be as detailed as possible as you enter the data in the tables. Remember, your goal is to make Scientific Observations, not Everyday Observations. Use your completed Background Research for details (such as usual features) on your topic.
3. Think about the surface features that you are observing - what interests you?
4. Work with people on your team to find other areas on Mars that have features you are interested in.

Credit: NASA

(Q) Observation Table (1 of 2)

NAME:_______________________________

Making Observations of THEMIS Images

Surface Geologic Features Observed & Image ID #	Sketch of Surface Geologic Features	Text Description of Surface Features (use bullets)
Image ID #:		
Image ID #:		
Image ID #:		
Image ID #:		

(Q) Observation Table (2 of 2)

NAME:______________________________

Making Observations of THEMIS Images

Surface Geologic Features Observed & Image ID #	Sketch of Surface Geologic Features	Text Description of Surface Features (use bullets)
Image ID #:		
Image ID #:		
Image ID #:		
Image ID #:		

(R) Choosing a Topic for Research

NAME:_______________________________

1. Review your scientific observations from the Observation Table. Choose two observations you found most interesting during your online research. These are observations you would like to share with the class and could turn into an interesting research project. Record them below.

Observation #1	Observation #2

2. After a class discussion about interesting scientific observations, list six major relevant categories within your topic – or features that the class can choose to study about Mars. For example, with volcanism think about related surface features such as lava flows, eruptions, volcanoes, ash and rock deposits. Once you have created the list, as a team debate and select your topic and relevant category.

_______________________________ _______________________________

_______________________________ _______________________________

_______________________________ _______________________________

3. List the topic your group will research: _______________________________