STUDENT GUIDE

MARS EXPLORATION
Student Data Teams

IMAGE ANALYSIS

JPL · ASU ARIZONA STATE UNIVERSITY · ARIZONA STATE UNIVERSITY MARS EDUCATION Program http://marsed.asu.edu

JET PROPULSION LABORATORY • ARIZONA STATE UNIVERSITY • MARS EDUCATION PROGRAM

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Introduction

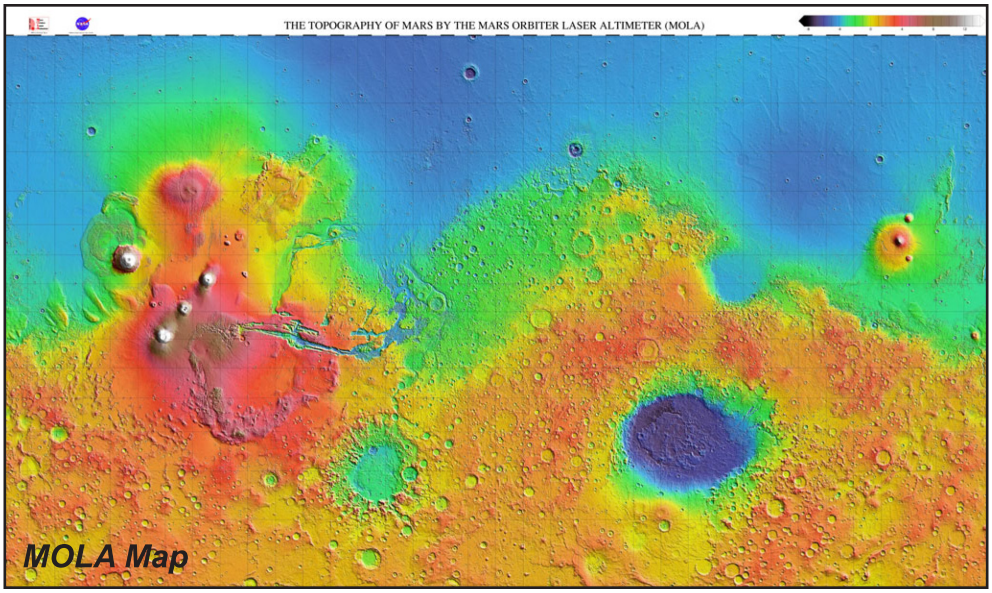
How do scientists understand and interpret the surface features of Mars from orbit and determine if a proposed landing site will meet the mission's science goals? The distance to Mars varies between 80 and 240 million kilometers (50 – 150 million miles). The planet is therefore studied using remote sensing 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.

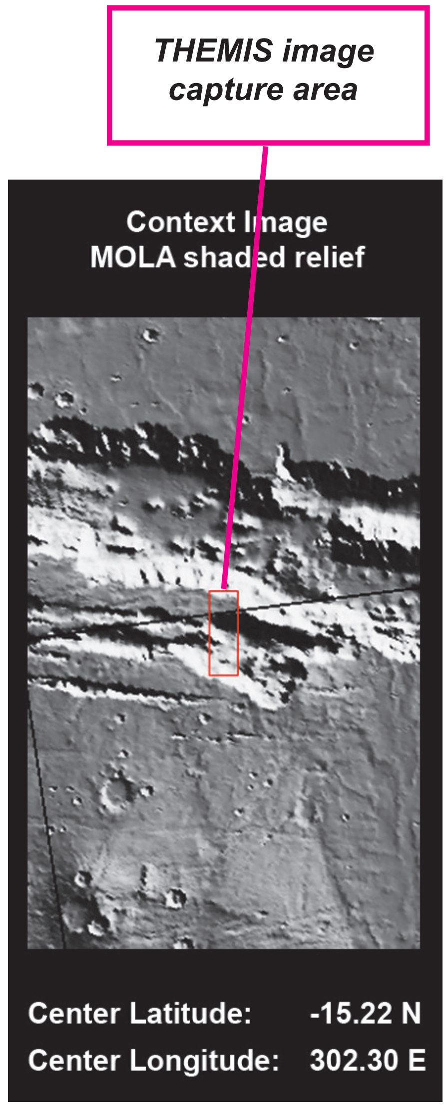
Planetary missions have to balance two critical areas – engineering and science. To have a successful mission, the engineers have to help to ensure the success of the spacecraft and mission success for landing by spacecraft design and landing site safety considerations. On the other hand, scientists want to argue for the area with the richest science return. These two groups don't always agree, but in real life must come to a compromise for a mission to go forward.

For this activity you will be placed in the role of scientists. You will complete five different tasks (parts of this lesson) to help you analyze an area of Mars and decide if you would recommend it as an area that is scientifically interesting enough to be considered as a potential landing site. To assist you with this recommendation, Part V of this activity discusses NASA's four goals for the exploration of Mars. You will need to consider if within the analysis of your image, any of these goals would be met. Recommended landing sites are then evaluated by a whole different set of criteria used by engineers. This was the process used with the landing site selection for the Mars Exploration Rovers.

Part One: Locating The Image On A Map

Part I of this activity asks you to focus on the context image provided and a map of Mars. The context image shows you the larger area on Mars where your Thermal Emission Imaging System (THEMIS) image was taken. The THEMIS image is illustrated with the box in the center of the context image. Using a MOLA map of Mars you will see a more global view of where your image was taken. Plot the location on the MOLA map. These resources will help you answer the questions below. Using the Data Sheet provided, answer the questions for each section.





1. What is the latitude and longitude of your THEMIS visible image of Mars?

Latitude:________________________Longitude:________________________

2. Looking at the title of your context image and THEMIS visible image, name the area/region in which your THEMIS visible image of Mars was taken?

Area/Region: ____

3. Describe the type of area in which the THEMIS visible image was taken. Is your image in an area with lots of craters? Is it near a volcano? Is it near an area where it looks like there was once water?

Area Description: ____

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Part Two—Identifying Surface Features

For this part of the activity, you will use erasable markers to label different features directly on your Thermal Emission Imaging System (THEMIS) visible image of Mars. To help you identify features, use the Surface Feature ID Charts and the descriptions provided. Keep in mind that some of the features in the Surface Feature ID Charts will not exactly match what you see in your THEMIS image.

If you have more than one example of the same feature, list those features with a number. For example, if there are three different craters in your image, identify them as Crater 1, Crater 2, Crater 3, etc.

What To Do:
On the Data Log Chart, list the features you found in your image. Write down your best hypothesis (scientific guess) as to how you think each of these features may have formed.

Using the Data Log Chart provided, answer the questions for each section.

Data Log Chart

THEMIS Image ID# ______________________________

Region of Mars _________________________________

Feature	How Feature May Have Formed	Age Rank (part III)	Measurement (part IV)

Part Three—Determining the Surface History

You now have identified features you see in your image. Next, think about the history of this area of Mars. What has happened to make this area of Mars look the way it does today? To determine the history of this area, you can use two geologic rules or principles. These rules will help you figure out the "relative ages" of features. Relative ages will not tell you the exact age of a feature. They will help you figure out what features are younger or older compared to one another. Two common rules you can use to determine relative ages of features are:

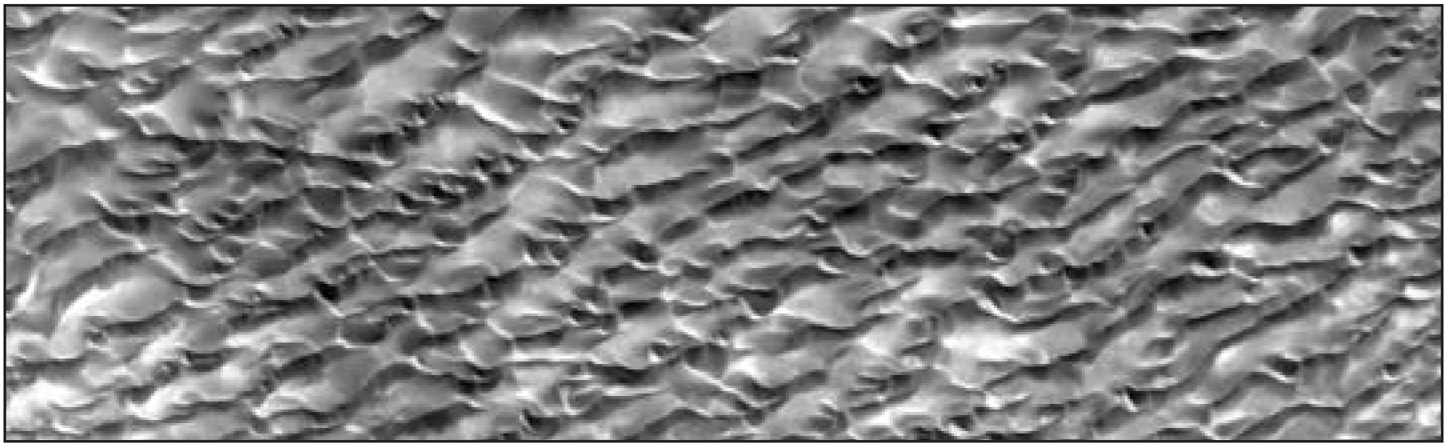
The Principle of Superposition:
This rule says that if one feature looks like it is placed on top of another, the feature on top is younger. An example of this can be seen in the crater image on the Surface Feature ID Chart. The crater is on top of the surface around it. Because of this rule, we can say the crater is younger than the nearby area.

The Principle of Cross-Cutting Relationships:
This rule says that if you have one feature that is cut by another feature, the feature that is cut is older. For example, look at the channel picture in the Surface Feature ID Chart. The channel looks like it cuts across the area. This means that the area is older. It also means the channel is younger. Another example of a cross-cutting relationship is Earth's Grand Canyon. In this case, you had rocks that were cut by the Colorado River. The result was the Grand Canyon itself. In this example, the rocks are the oldest because they were there first. The canyon itself is younger, since it was formed by the Colorado River that cut through the rocks that were there to begin with.

Sometimes you can also see how worn down a feature looks. This can also help you figure out the relative ages of features. Features that have been around longer are most likely more affected by erosion. A feature that is more worn down or eroded is most likely older.

What To Do:
In Part II, you identified features in your image on the Data Log Chart and included information as to how those features may have formed. In this part of the activity, rank the features listed on the Data Log Chart according to their relative ages. The oldest feature should be numbered one (1) and the younger features should be numbered two, three, four, etc.

Using the Data Log Chart provided in part 2 (page SG-3), answer the questions for each section.



Part Four—Measuring Features

In this part of the activity, you will measure features. This information will help you understand this area of Mars better. It may also help you decide if you would recommend this area as a potential landing site. In order to measure features in your image, you need to figure out the scale of your image.

Scale:
Thermal Emission Imaging System (THEMIS) visible images are 18 km in width. You need to know the scale of the image you are working with to correctly measure features.

To figure out the scale factor of your image, complete the following steps:

1. Use a ruler to measure the width of your image. Measure this in centimeters. This measurement should be taken to the nearest tenth of a centimeter (example: 35.3 cm).

The width of your image is: __________cm

2. Divide 18 km (the actual width of this area on Mars) by that measurement.

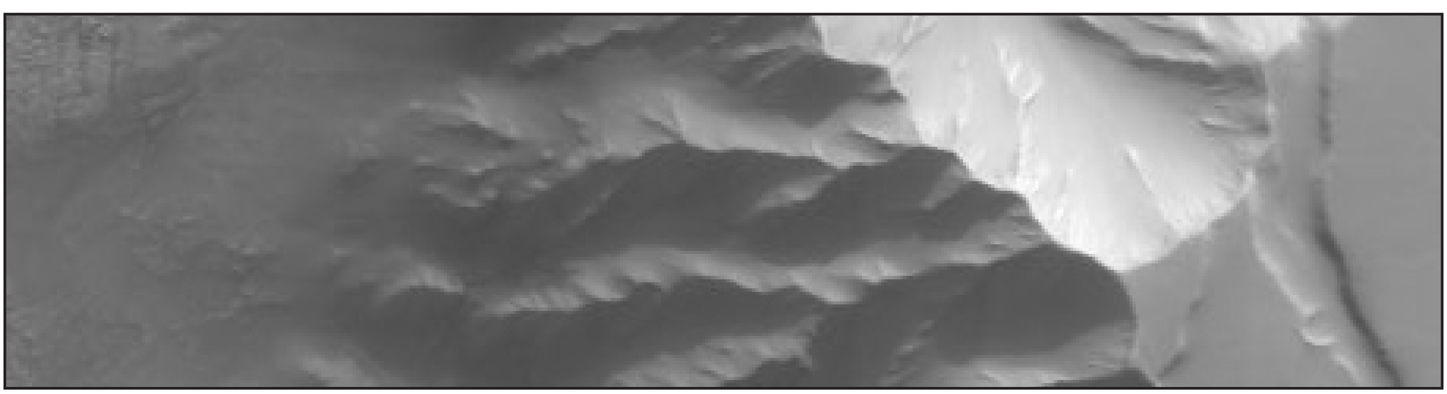
_______ cm / 18 km = _____________ km/cm

3. This answer gives you the scale factor of your image in km per cm.

You can now figure out actual measurements of features on Mars in your image. To do this, complete the following steps:

1. Measure a feature in centimeters.
2. Multiply that measurement by the scale factor you figured out.
3. The answer you get will give you the measurement of that feature on Mars in kilometers.

What to do:
After you have figured out the scale factor of your image, measure all the features you identified in your THEMIS visible image with your ruler. Figure out how the measurement of those features on Mars in kilometers. Fill in the information on the Data Log Chart provided in part 2 (page SG-3).



Part Five—Landing Site Evaluation

You have now identified, measured and determined the relatives ages for the different features in your image. It is now your job to decide if you would recommend this area as a potential landing site for a future Mars lander mission. As a scientist, you need to decide if this area of Mars is geologically interesting and also if it would meet any of NASA's main goals for all mission to Mars. Those goals are as follows:

1. Determine if life ever existed on Mars
2. Characterize the climate of Mars
3. Characterize the geology of Mars
4. Prepare for future human exploration of Mars.

The overall strategy that corresponds to each of these goals is the "follow the water" theme. On Earth, wherever we find water, we find life. Was that the same for Mars? With future missions, we hope to find out.

What to do:
Look over all the information you have completed for this activity and answer the questions below.

1. Write a brief geological "story" of this image. What happened to make this area of Mars appear the way it does today?

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2. Considering NASA's four main goals for mission to Mars, which goal(s) does this area of Mars meet? Please explain.

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3. Is there any evidence that water was present in this area on Mars? (Yes or No?) ________
   What evidence can you provide for your answer?

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4. Would you recommend this area of Mars as a potential landing site? Explain how you arrived at your decision.

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