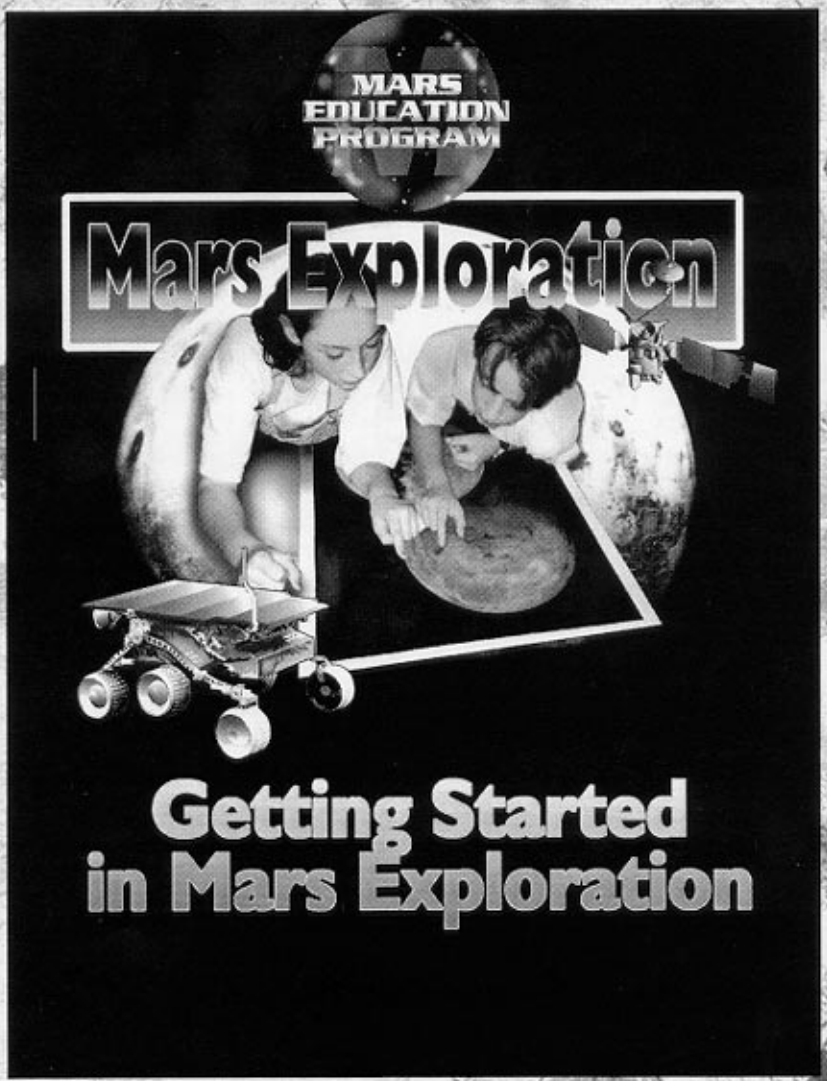
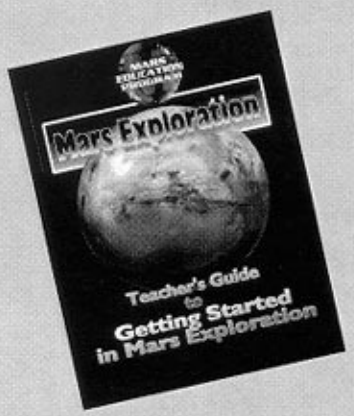
Part II
Teacher's Guide to Getting Started in Mars Exploration



WELCOME

The Getting Started in Mars Exploration Module is the first module of the Mars Education Program. It lays the foundation for your students, helping them learn a few basic concepts about Mars and Mars exploration and engaging them in some of the excitement and mystery of Mars. We hope it also encourages you and your students to continue with other Mars modules.



The Getting Started Module has a Teacher's Guide (this section) and a Student Guidebook (with information, images and activities for students). You should have one Teacher's Guide and enough Student Guidebooks so that each student has one.

The Getting Started is the first module. Other modules deal with themes, such as Canyons, Valleys, Volcanoes and Atmosphere, and with up-coming missions to Mars, such as Mars Global Surveyor and Mars Pathfinder.

GETTING STARTED

This Teacher's Guide is relatively brief, so that you can start quickly. First, a few comments:

1. **Mars Exploration Journal** — Make sure that each student creates his or her own Mars Exploration Journal. Your students will record their data, observations, analyses and questions in their journal, helping them consolidate, personalize and extend their learning.

2. **Student Guidebook** — You should have enough copies to distribute one to each student. The Student Guidebooks can be reused, although new versions will probably be released each year as the Mars missions reveal new information about Mars.

3. **Mars posters** — In the Resource section, we suggest several posters that highlight Mars and the Mars missions. You should purchase these and display them prominently in your room. They will help with the activities in this and other modules.

SUGGESTED DAILY SCHEDULE

You should be able to complete the Getting Started Module in about two weeks. The core science concepts emerge for the students through a series of activities that, more or less, trace the historical process of discovery from the ancient Greek astronomers to the modern robotic missions. Below is a suggested daily schedule.

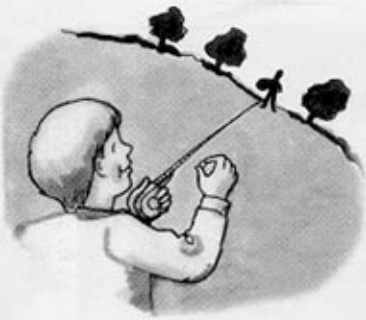
Please refer to the images and other information in the Student Guidebook.

Days 1 & 2 — Mars in the Night-time Sky

Mars is a planet. It orbits the Sun, just as Earth does. Ancient astronomers did not know this, they just noticed that some "stars" changed their position from one night to the next. They also noticed that the "wanderer" they called Mars appeared faintly red.

Activity: "Make Your Mars Exploration Journal" — *Students create their own journal to record their data, observations, questions, and ideas about Mars.*

Activity: "Find Mars in the Night-time Sky" — *Your students go outside at night and look for Mars, based on position data presented in the Student Guidebook. This makes Mars real for them, and helps them appreciate how little you can learn about a planet with the naked eye.*



Days 3 & 4 — Understanding the Solar System

Over the centuries as astronomers collected more and more data on the motion of the planets, they began to realize that the Sun was the center of the solar system, and that Earth and Mars are both planets in orbit around the sun. They also began to realize how large the Solar System is.

Activity: "How do the Planets Compare in Size?" — *Your students make models of the planets, in proportional size.*

Activity: "How far are the planets from the Sun?" — *Your students place the scale models in their relative locations and distances from the Sun.*

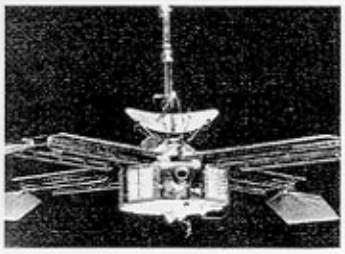
Day 5 — Mars through a Telescope

With the advent of the telescope in the 1600's, astronomers were able to see Mars as more than just a reddish point of light. They could see very rough details, including white areas on the poles which grew and shrank over the course of several months. They guessed that these were polar ice caps which changed in size over the Martian year. The telescope was tantalizing. It showed faint shapes and hinted but did not reveal details of the surface. So, scientists speculated: There might be life on Mars. Mars might have canals made by Martians. Mars might have a hot core with volcanoes. Mars might be too dry to support life.

Activity: "Examining a Telescope Image of Mars" — *Your students see two sample images of Mars from a telescope and try to find similarities and differences between them.*

Activity: "What are your speculations?" — *Your students make their own guesses about what they think Mars is like, and think about what data they would need to confirm or refute the speculations. This helps them appreciate that exploring a planet involves conjectures, that more evidence is needed for each conjecture, and that they can make their own conjectures as they try to figure out what processes have affected Mars.*

Day 6 — Mariner 4 Flies Past Mars



In 1965, NASA succeeded in sending a robotic mission to Mars. Mariner 4 was a "fly-by" which took 21 pictures as it flew past Mars. This was a major technical success, and the first time humans had a close-up look at another planet. It revealed a surface that was covered with craters and showed no signs of life.

Activity: "What are those circles?" — *Your students look at one of the Mariner 4 images, and try to figure out what the circles are (impact craters). They also drop rocks into a tray of mud to model the formation of craters.*

SUGGESTED DAILY SCHEDULE

Day 7 — Detailed Images from Orbit Around Mars

In 1971, Mariner 9 went into orbit around Mars. This was followed in 1976, by two Viking spacecraft. These orbiting spacecraft revealed much new detail about the surface of Mars. Scientists studied the pictures of Mars taken from orbit and found dust storms, surface fractures, volcanoes, and the evidence of surface water from the ancient past. The ability to interpret these images is an important skill for scientists and for your students.

Activity: "Studying Viking Images of Mars" — *Your students, working in small groups, look at a series of eight images of the surface of Mars. They try to figure out what the images show. At this point, their efforts are speculation. In later modules, they will learn more about the processes affecting the surface of Mars. (Refer to the Mars Images - Teacher Notes, later in this Teacher's Guide)*

Day 8 — Viking Lands on the Surface of Mars

Each Viking spacecraft included both an orbiter and a lander. The Viking landers successfully reached the surface of Mars. They showed pictures of a rocky, dry, dusty surface. They conducted experiments and found no signs of life. They also made weather measurements over an extended period of time.

Activity: "On the Surface of Mars" — *Your students look at one of the pictures taken from the surface and describe what they see. They also compare Mars weather data with their own local data.*

Day 9 — Life on Mars?

In the past ten years, scientists have concluded that some of the meteorites which land on Earth are probably from Mars, knocked off the Martian surface as the result of meteorite impacts. In August 1996, NASA scientists studying one of the Mars meteorites announced that the rock had possible evidence of ancient life on Mars! This primitive one-celled fossil would probably have been formed approximately 3 billion years ago, when scientists believe there used to be lakes and flowing water on Mars. The search for ancient or even present life on Mars is closely related to the search for surface or sub-surface water.

Activity: "Water on Mars?" — *Your students look at images which show evidence of water flowing on Mars billions of years ago and evidence of sub-surface ice melted by the impact of a crater. Students begin to experience the excitement of the search for evidence of life on Mars.*

Day 10 — New Missions to Mars

NASA is returning to Mars with a ten-year series of robotic missions. The student materials describe Mars Pathfinder (a lander) and Mars Global Surveyor (an orbiter). The student materials introduce the instruments on each mission, the science questions they are trying to answer, and the mission schedules. The mission schedules are important, because you will monitor the progress of these missions as they launch and travel to Mars, and you will begin to get new images and data that you can use very shortly after the missions arrive.

Activity: "How Mars Pathfinder will land and explore Mars" — *Your students look at a scrambled sequence of four drawings of the landing sequence. They try to deduce the correct sequence. (refer to the Mars Images - Teacher Notes, later in this Teacher's Guide)*

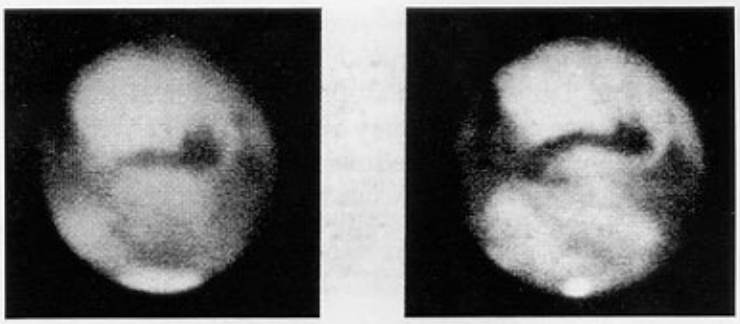
Activity: "How will you get ready?" — *Your students study the details of the mission schedules. Then you and your students discuss and plan for the modules and other activities you will do to prepare for the arrival of the missions and your use of the new data and images.*

MAKING SENSE OF THE IMAGES

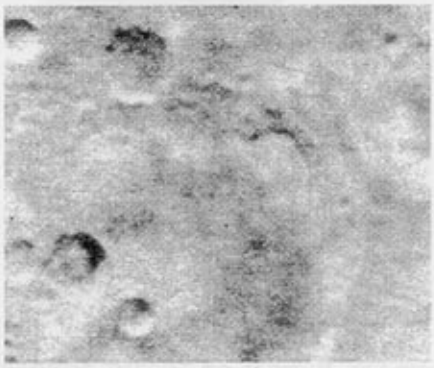
Throughout the Getting Started Module, students examine images of Mars, taken by telescope and by spacecraft that orbited and landed on Mars. Your students will be developing some of the same skills that planetary scientists use — the ability to look at an image of another planet, and speculate about what they see in the image and what types of geological or atmospheric processes are at work.

Do NOT tell your students what the images show. Rather, use the notes below to help yourself understand the images (interpreting these images is probably as new an experience for you as it is for your students). With the background information here, you can help guide your students in this discovery and exploration process. The goal at this introductory stage is not to teach students the "facts about Mars", but rather for them to directly experience the process of investigation and discovery. This is what the National Science Education Standards call "science as inquiry."

We suggest that you have students work in small groups as they explore and discuss the images.



Mars through a telescope (p 14) — These two fuzzy images show Mars through a telescope. Very few details can be discerned. The most interesting feature is at the very bottom. The white area is larger on the left image, and smaller on the right image. This is the south pole, with a cap of ice which expands in Martian southern winter, and contracts in Martian southern summer.



Mars from Mariner 4 (p. 19) — This is one of the first close-up pictures of Mars. The shapes are craters, caused by the impact of meteorites on the surface.

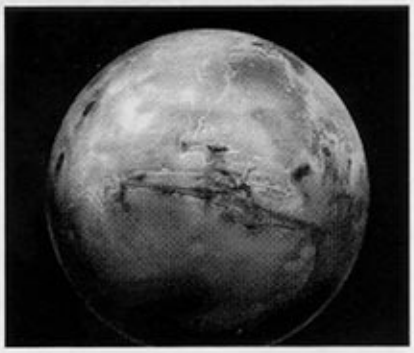


Image #1 (p. 22) — This image shows Mars as if you were approaching it from space. This hemisphere includes the huge canyon across the middle (Valles Marineris), impact craters, and two volcanoes (the round spots on the upper left edge).

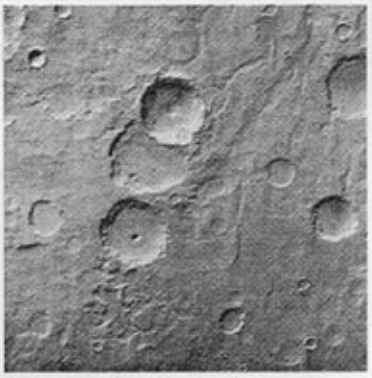


Image #2 (p. 22) — Much of the surface of Mars is covered with craters. In this image, students can see craters of varying sizes. These craters were formed as meteors struck Mars. Some of the craters overlap, caused by one impact happening after the other. You might ask your students which of the craters came first and which second.

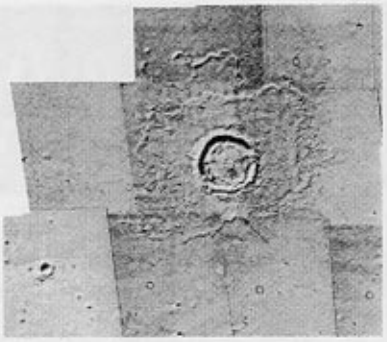


Image #3 (p. 23) — In this image, there is an "oozy" appearance around the crater. Scientists speculate that when the meteor that caused this crater hit Mars, the impact caused frozen water under the surface to melt. This made the surface soil become muddy and spread around the crater. In a later module, your students will do experiments to create their own craters using rocks, sand and mud.

Image #4 (p. 23) — Mars has huge dust storms sometimes covering the entire planet. This image shows such a dust storm. It is a bit fuzzy and may be harder for students to interpret than the other images. It is a top-down view of the surface of Mars. In the background on the right surface, craters can be seen. In the foreground, the turbulence is a dust storm with particles smaller than sand being picked up by the strong winds. As these dust storms spread dust over large areas of the planet, the changes they cause can sometimes be seen from Earth-based telescopes.

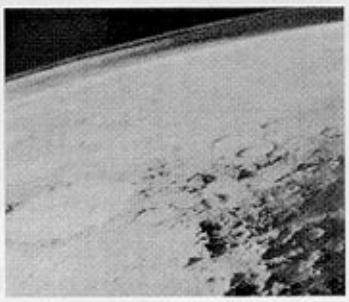


Image #5 (p. 24) — In the foreground, this image shows a very large crater (Argyre Planitia). Of special interest in this picture is the horizon. Above the edge of the planet's surface is a haze. This is Mars' atmosphere. The hazy appearance is dust from a dust storm.

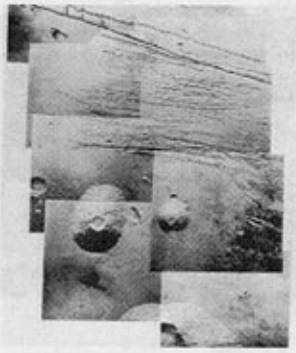
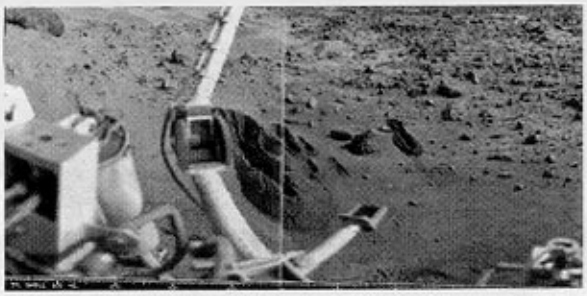


Image #6 (p. 24) — The surface of Mars has volcanoes, none of which appear to be active. This image shows two volcanoes. These are shield volcanoes, formed as basaltic lava from beneath the surface rose and spread out from the center of the volcano. Also, notice the impact craters on the sides of both volcanoes. This image also shows long straight lines which are fractures in the surface of Mars.

Image #7 (p. 25) — Mars has many valleys and canyons. Your students will learn more about them in the Grand Canyon of Mars Module. This image shows just one part of the huge Valles Marineris, a canyon which is roughly as long as the US is wide. In this image, your students can see landslides on the edges of the canyon.

Image #8 (p. 25) — This image is an excellent final image for your students to explore in that it shows a rich diversity of geological processes. There are craters, a valley, wind streaks, and fracture lines. This would be a good final image for a full class discussion.



Viking image of Mars' surface (p. 27) — This picture of the surface of Mars shows rocks of varying sizes (note the large boulder in the extreme upper left) and sand or dust (note the wind-blown dunes in the top left). The gouges in the lower middle are the result of the scooping up of surface for the Mars biology experiments. In the foreground are the instruments from the Viking lander. Around the border are calibration markings.

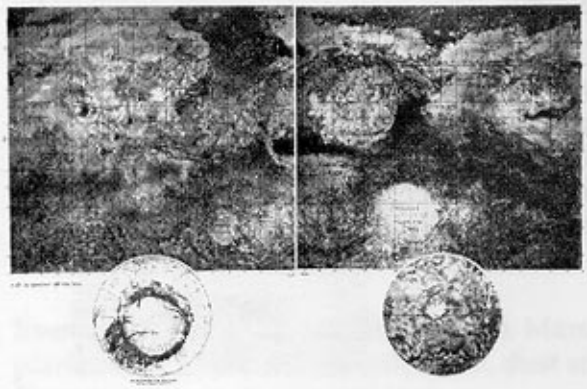
#1 a parachute slows the craft further and the shell is released

#2 balloons deploy around the craft, and bounce to a landing

#3 balloons deflate and the petals open

#4 rover is released, rolls off and begins to explore

Mars Pathfinder landing sequence (p. 33) — Mars Pathfinder uses experimental new landing techniques. Not shown are two pre-cursor steps: retro-rockets and aero-braking with the protective shell.



Map of Mars (pp. 38-39) — This is a map of the full surface of Mars. The circled numbers refer to the numbered images above. A more detailed map of Mars is available, and recommended, in the resource list.

RESOURCES

Posters

Mars Pathfinder and *Mars Global Surveyor,*
(while supplies last)

Mars Exploration Education and
Public Outreach Program
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-6111

Video

Mars Pathfinder, (while supplies last)

Mars Exploration Education and
Public Outreach Program, see above address.

CD-ROMs

Mars Navigator Interactive Multimedia CD-ROM,
describes JPL's *Mars Global Surveyor* and
Mars Pathfinder missions (while supplies last)

Mars Exploration Education and Public Outreach
Program, see above address.

The Mars Educational Multimedia CD-ROM,
provides a Mars atlas, Mars-based lesson plans, descriptive information about Mars, image processing software to extract information from the images in the Mars atlas and from new images acquired by future orbiter and lander missions.

The Center for Mars Exploration,
Mail Stop 245-1
NASA Ames Space Science Division
Moffett Field, CA 94035-1000
(415) 604-4217
Recommended ordering procedure:
http://cmex-www.arc.nasa.gov

Web Sites

Mars Global Surveyor: http://mgs-www.jpl.nasa.gov/

Mars Pathfinder: http://mpfwww.jpl.nasa.gov

Jet Propulsion Laboratory: http://www.jpl.nasa.gov/

Center for Mars Exploration:
http://cmex-www.arc.nasa.gov/

The Planetary Society: http://planetary.org/tps/

Arizona Mars K-12 Education Program
http://esther.la.asu.edu/asu_tes/

Periodicals

The Planetary Report

The Planetary Society
65 North Catalina Avenue
Pasadena, CA 91106-2301
(818) 793-5100 (phone)
(818) 793-5528 (fax)

Mars Underground News

The Planetary Society, see above address

Recommended Maps and Photomosaics of Selected Martian Features,

General:

Map of Olympus Mons to Ares Vallis	I-1618
Map of Eastern Valles Marineris to Ares Vallis	I-1448
Topographic Map of Mars (1:25,000,000) (1 map)	I-961
Topographic Map of Mars (1:15,000,000) (3 maps)	I-2160

Volcanoes:

Photomosaic of Olympus Mons	I-1379
Map and photomosaic of Tharsis volcanoes	I-1922

Canyons:

Map of Central Valles Marineris	I-1253
Photomosaic of entire Valles Marineris	I-1206, I-1207,I-1208, I-1184, I-1381

Floods

Photomosaic of channels and eroded landforms	I-1652
Photomosaic Dromore crater with breached ridge	I-1068

Pathfinder

Map of Ares Vallis	I-1551
Photomosaic of the flood channels near landing site	I-1343
Close-up photomosaic of landing site	I-1345 & I- 2311

($4.00, 3-4-week turn around)
United States Geologic Survey
Box 25286
Federal Center, Building 810
Denver, CO 80225
(800) 435-7627

Mars Exploration Education and Public Outreach Program

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These curriculum materials were developed through a sub-contract to TERC, Inc., a non-profit educational research and development company. The materials have been field-tested by teachers and reviewed by scientists. New versions of the materials will be released periodically, incorporating new discoveries about Mars and improvements based on teacher feedback.

For these materials,and others related to the modules please contact:

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818-354-6111

	Getting Started	Canyons	Pathfinder Landing Site	Volcanoes	Mars Pathfinder	Mars Global Surveyor
TEACHER'S MATERIALS	Teacher's Guide	Teacher Handbook	Teacher Handbook	tba	tba	tba
STUDENT'S MATERIALS	Student Guidebook	Canyons Image Set	Pathfinder Landing Site Image Set	tba	tba	tba