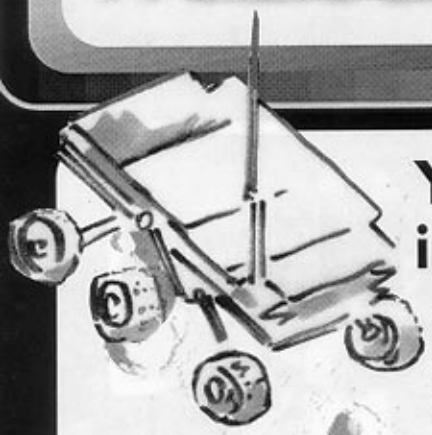
MARS EDUCATION PROGRAM

Mars Exploration

Getting Started in Mars Exploration

Jet Propulsion Lab
Mars Exploration Education and Public Outreach Program

WELCOME TO NASA'S MARS



You are about to begin an important and historic adventure.

NASA will soon be sending a series of robotic missions to the planet Mars. For these missions, you will become active members of NASA's Mars Exploration Team. Never before have students been so actively involved in an actual planetary mission.

When these missions arrive at Mars, you can use your computer at school or at home to see live images from the surface of Mars, detailed pictures of Mars taken from orbit, and additional data from Mars (all within hours, days or weeks of the actual events). You will work in parallel with the scientists to analyze these images, trying to find answers to questions about Mars — answers that even the scientists don't yet know. You may even be able to select your own targets on Mars for the orbiting camera photograph.

S EXPLORATION PROGRAM

Your Mars Exploration Journal

Your personal Mars Exploration Journal is a notebook where you record your notes and ideas as you learn about Mars. Your notebook will also include observations from your classroom experiments, sketches that you draw and questions that occur to you as you learn and explore.

Activity — Make your Mars Exploration Journal

On the cover of your journal:

1. Write Mars Exploration Journal
2. Write your name
3. Write "Start Date:", and then write today's date
4. Draw a picture of Mars, one of the Mars spacecraft, or a Mars-related picture you think would look good on the cover of your journal.

Activity

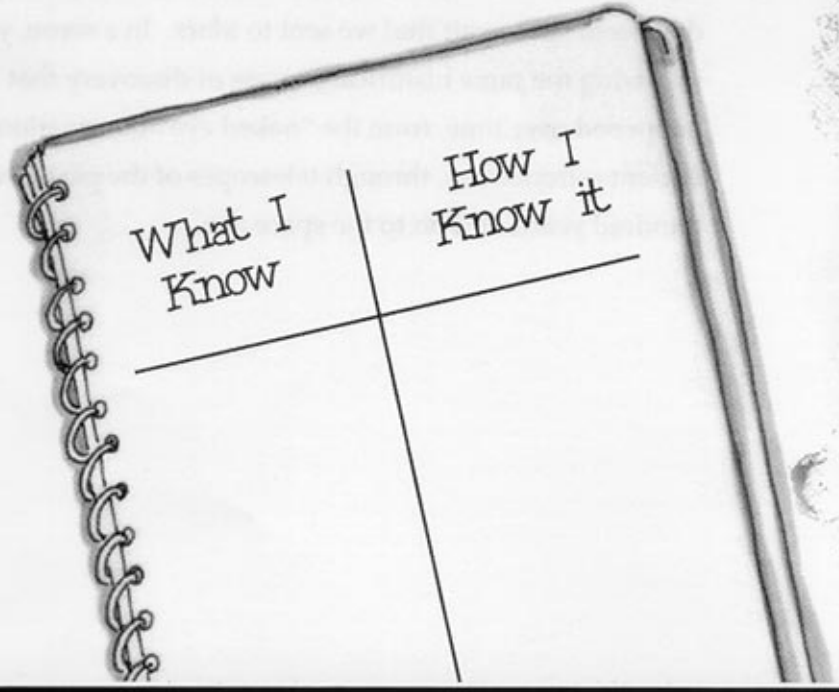
What do you think Mars is like?

Maybe you know very little about Mars, or maybe you've been interested in Mars and have done a lot of studying about it. In any case:

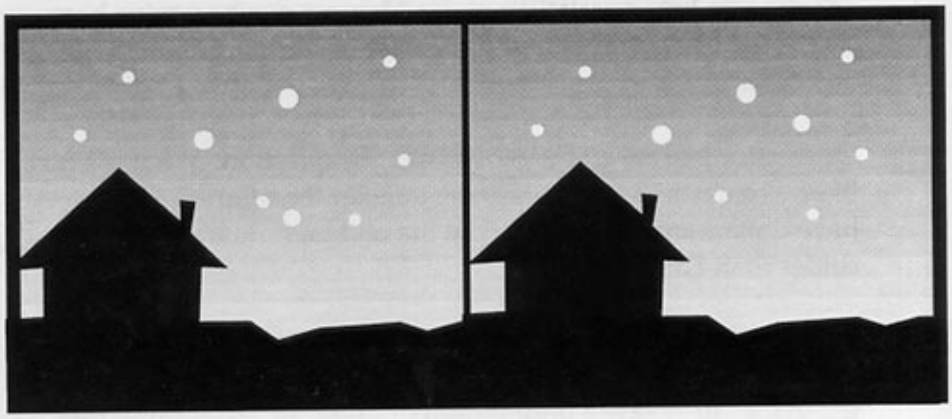
1. Open your journal and try to answer the question: What is Mars like? For example: Is it bigger or smaller than Earth? Does it have oceans and rivers? Is there life on Mars? Is it hotter or colder than Earth? etc.

2. Now, go through the list, and next to each item, write why you think it is true. For example, "I looked at Mars through a telescope" or "I saw a photograph of Mars" or "somebody told me" or "I read it in a book." If it is a guess, then just write "This is a guess."

This page in your journal shows what you know about Mars right now. Later you will refer back to this list to see how much you have learned by doing these Mars activities.



Mars is a Wanderer



May 1, 1996 *May 8, 1996*

During the next few weeks, you will learn about Mars in very much the same way scientists did. You will look at Mars in the sky, then see telescope images of Mars, then study images and data from spacecraft that we sent to Mars. In a sense, you are following the same historical process of discovery that happened over time, from the "naked eye" observations of ancient astronomers, through telescopes of the past few hundred years, and on to the space age.

Activity

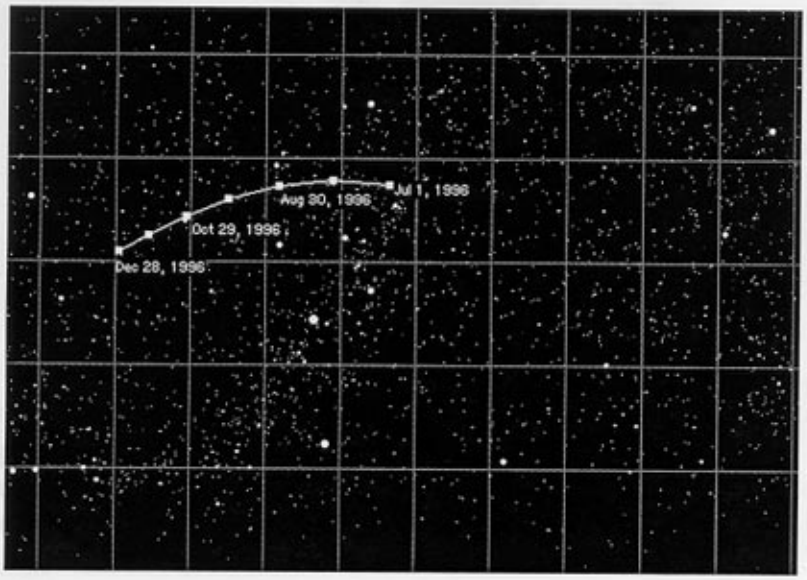
Mars is a Wanderer in the Night-Time Sky

Ancient astronomers all over the world were fascinated by "stars" that changed their positions in the sky. The Greeks called them planets, which means "wanderer." Mars is one of several "wanderers."

Look at the two pictures on the left. They are almost exactly alike. They show the position of several stars (and one planet) in the night time sky. The picture on the left is May 1, 1996; the one on the right is May 8 1996, one week later.

1. Find a difference between the two pictures.

2. Did you see that there is one point that is in a different location? That point is Mars. That was the first thing ancient astronomers noticed about Mars — that it changed its location among the stars. Why do you think it moves?



Sky map showing Mars' location, from July to December 1996

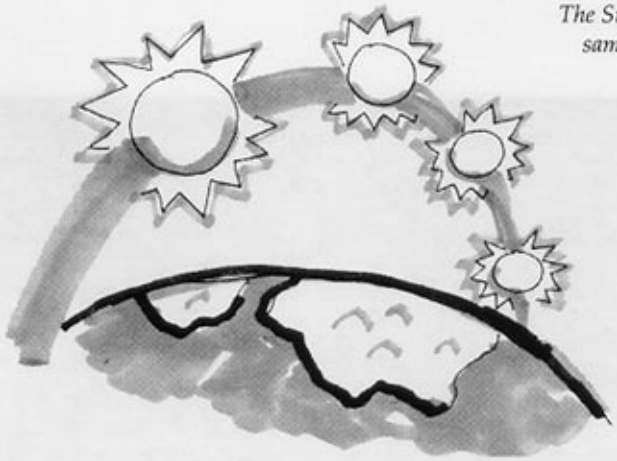
Find Mars in the Night-Time Sky

Date	Mars Rise Time
Dec 31, 1996	11:15 pm
Jan 15, 1997	10:35 pm
Jan 31,1997	9:45 pm
Feb 15, 1997	8:45 pm
Feb 28, 1997	7:35 pm
Mar 15, 1997	6:15 pm
Mar 31, 1997	4:40 pm

Times are plus or minus 30 minutes
Use the same rise time regardless of time zone

Go outside at night and look at the stars. Of all those dots of light, which one is Mars? Or, can you even see Mars at all? Fortunately, you will be able to see Mars during the second half of 1996 and most of 1997. Here is how to know where to look.

Activity — Where Is Mars?



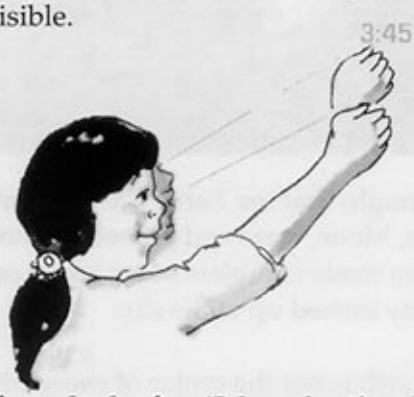
The Sun and Mars follow the same path across the sky

1. **Find the path of the Sun** — Mars follows the same path in the sky as the Sun. Notice where the Sun rises, where it is every couple of hours, and where it sets. Practicing tracing this band from sunrise to sunset. You will need to be able to trace the band even when the sun isn't there. This band is called the ecliptic.

2. **Find out what time Mars rises** — On the left of this page is a chart which lists the time Mars rises, from October 1996 to March 1997. Look for today's date (or the nearest date) and write down the time that Mars will rise. This time is approximate, give or take a half hour (actual rise time depends on your location).

3 **Decide what time you will look for Mars** — The only time that you can look for Mars is after "Mars rise time" (so that it will be in the sky) and at night (so it is dark enough to see Mars). Decide what time you will go outside to look for Mars. You may have to stay up late or get up early.

4 **If you look at "Mars rise time"** — If you go outside at the "Mars rise time" listed for today, and have a clear view of the eastern horizon, you will see Mars slowly rise at the same place that the Sun normally rises. In fact, it's probably better to wait an hour or so, in order for Mars to be high enough above the horizon to be visible.



Mars moves about the width of a fist every 45 minutes

5 **If you look after "Mars rise time"** — Mars will move across the sky following the same band as the sun (the ecliptic). It will take about six hours from the rise time until Mars reaches the highest point in the sky. So, you have to figure out how far along the ecliptic to look. Here's an easy way to do this.

6 If you hold your fist out at arm's length, your fist shows how far Mars (or any other planet or star) will move in about 45 minutes. So, if you look 45 minutes after Mars rise, Mars will be about one fist-width above the horizon. If you look 90 minutes after Mars rise, it will be two fist-widths above the horizon.

7 Calculate how many minutes after Mars rise you are looking for Mars, divide by 45 minutes, and you will know how many "fist-widths" above the horizon you should look. Remember, Mars will be moving along the same path that the Sun moves.

8 **How will you know if you have found Mars?**

- It will be brighter than most stars (but about the same size).
- It might appear reddish
- After several days, it will be in a different position in relation to the stars around it.

Tycho Brahe was a Danish astronomer, who made very careful measurements of the motion of the planets, and their rise and set times, over many years. His observations helped astronomers understand more about the planets and their orbits around the sun.

Timeline: 1590

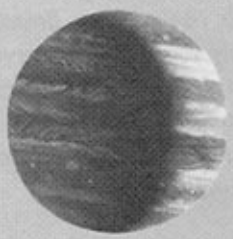
THE PLANETS &
THEIR REALITIVE SIZES

Mercury

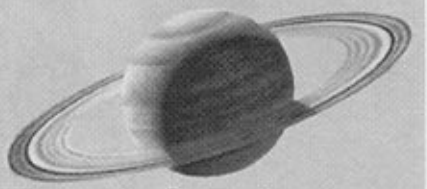
Venus

Earth

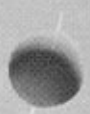
Mars



Jupiter



Saturn

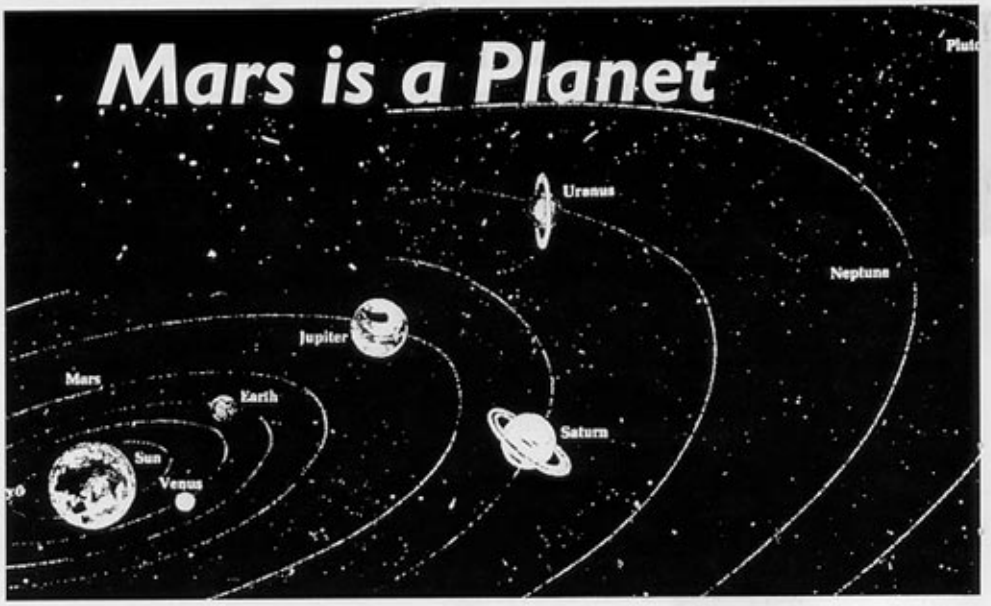


Uranus

Neptune

Pluto

Mars is a Planet



For a long time, people thought that the Earth was the center of the Universe, with the Sun, Moon, stars and planets circling around the Earth. This idea made complete sense based on what people saw when they looked up at the sky.

Today we know that the Earth is not the center of everything. The Universe is incredibly huge, with many more stars than we can see at night. Our Sun is just one of those stars, although it certainly is the most important one for us.

Earth and Mars are both planets which go around the Sun. There are a total of nine planets in our Solar System.

Though all nine planets are the same shape — roughly spherical — they vary considerably in their sizes. Looking at them in the sky is no real help in comprehending their sizes because, at great distances, even the giant planets appear as dots in the sky. In this activity, you will make models of the planets, in order to compare their sizes.

Activity

How Do the Planets Compare in Size?

Materials: *paper, scissors, pen or pencil, drawing compass, ruler*

At the right is a table called "Sizes of the Planets." For each planet, it shows the actual diameter in kilometers. It also shows how to create a scale model that is one billion times smaller than the real Solar System.

Planet	Actual Diameter	Scaled Diameter
Mercury	4,880 km	0.5 cm
Venus	12,100 km	1.2 cm
Earth	12,800 km	1.3 cm
Mars	6,800 km	0.7 cm
Jupiter	142,000 km	14.2 cm
Saturn	120,000 km	12.0 cm
Uranus	51,200 km	5.1 cm
Neptune	48,600 km	4.9 cm
Pluto	2,200 km	0.2 cm
Sun	1,392,000 km	139.2 cm

Scaled diameter is 1 billionth of actual size

1. To make two-dimensional paper models of each planet, find the "scaled diameter" column. Start with the Earth. Earth's real diameter is 12,800 km. The "scaled diameter," at one billionth reduction, is 1.3 cm (actually it is 1.28 cm, but we have rounded off to the nearest tenth of a cm). Use a compass to draw a circle that is 1.3 cm in diameter and cut it out with scissors.
This circle represents Earth.

2. Continue this with all the other planets. For each planet, cut out a circle that is the "scaled diameter." Label each planet with its name and diameter. *(Mercury and Pluto may be to small to label).*

3. After you cut out all the planets, glue or tape them into your journal. One student in the class should set aside the paper planets and not glue them to his or her journal. You will need them for the next activity.

4. Finally, make a scale model of the Sun. It will be much bigger than the planets. Tape several pages of newspaper together, to make a sheet that is large enough to make the Sun. Cut out a circle that is 139 centimeters in diameter and label it "Sun".

5. Discuss in class or write in your journal:
   - How do the planets compare in size?
   - Which planet is the largest? smallest?
   - Which is most nearly the size of Earth?
   - Is Mars larger or smaller than Earth?
   - What surprised you most about this activity?

How far are the planets from the Sun?

Distances from the Sun

Planet	Actual Distance	Scaled Distance
Mercury	58,000,000 km	58 m
Venus	108,000,000 km	108 m
Earth	150,000,000 km	150 m
Mars	228,000,000 km	228 m
Jupiter	778,000,000 km	778 m
Saturn	1,424,000,000 km	1,424 m
Uranus	2,867,000,000 km	2,867 m
Neptune	4,488,000,000 km	4,488 m
Pluto	5,910,000,000 km	5,910 m

Scaled distance is 1 billionth of actual distance

You have made a scale model showing the size of the planets. The next step is to make a model showing how far they are from the Sun.

Activity: Make a Scale Model of the Planets in Orbit

Materials: *meter stick or metric tape measure*

1. At this one-billionth scale, how far is the Earth from the Sun? Go outside with the scale models of the Sun and the planets. Find a large space such as a playing field. Put the Sun on the ground at one end of the field. Walk away from the Sun and stop where you think the Earth belongs at this scale.

2. Now look at the data table on the left of this page, look at the actual distance from the Sun to the Earth, and look at the scaled distance. You will see that the Earth is 150 meters away from the Sun at this scale. Put the scaled Earth on the ground at this distance.

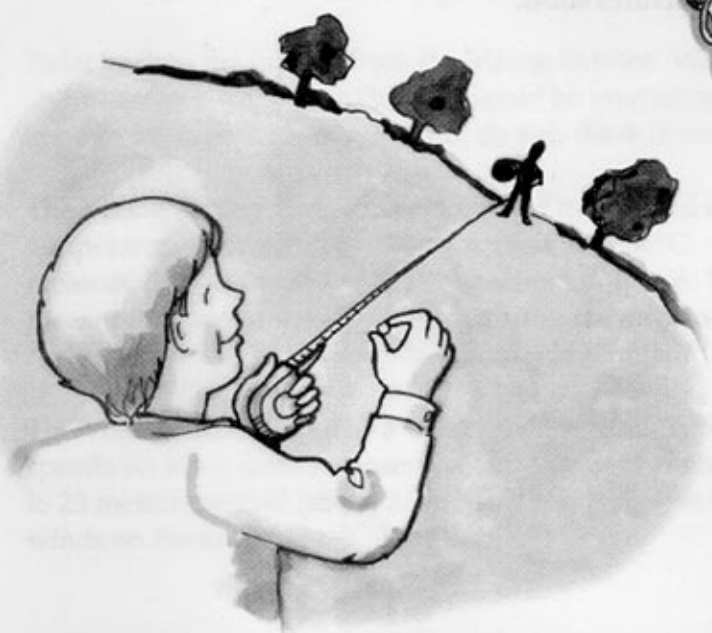
3. Now think about Mars. Where would Mars be at this scale? Closer to the Sun? Farther away? Walk to the place where you think Mars belongs.

4. Look again at the data table, and find the scaled distance from the Sun to Mars, and measure off this distance. Put the paper cut-out of Mars there.

5. Now use the data table to correctly position Mercury and Venus. Again put the paper cut-outs there. You have now completed what are called the inner planets.

6. The outer planets are even farther away. In fact, they are so far away in this scale model that they will probably not fit on your school property. Try Jupiter.

7. Do the same for Saturn, Uranus, Neptune and Pluto. If you have a map of the area around your school, you can mark where these planets would be.



Journal

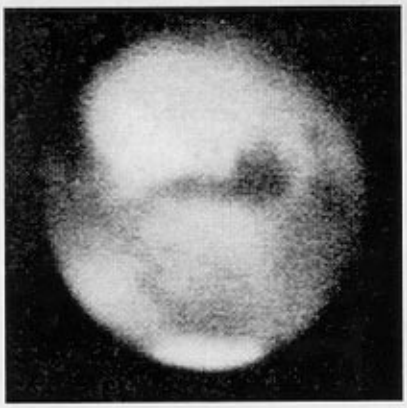
Discuss in class or write in your journal:

- Of all the planets, which planet is the closest to the Sun? The farthest?
- Is Mars or Earth closer to the Sun?
- Do you think Mars is warmer or colder than Earth? Why?
- At this scale, how big would you be?
- What surprised you most about this activity?

Mars Through a Telescope

Galileo Galilei was the first person to look at the stars and planets with a telescope. He made many important discoveries.

Timeline: 1609



Have you ever looked at planets or stars through a telescope?

Telescopes enable us to see some surface features of the planets, in ways that we never could with the naked eye. If you have a telescope or binoculars, go outside and use them to look at Mars. If you look carefully, you may be able to see some of the details that these pictures show.

Activity

Examining a Telescope Image of Mars

On the previous page are two images of Mars as seen through a telescope. The pictures were taken six months apart.

1. Look carefully at the picture on the left. What do you see on the surface of Mars? Make your best guess as to what the fuzzy shapes are. Discuss in class or write your ideas in your journal.

2. Now look at both pictures. How are the two pictures the same and how are they different? Why do you think the size of the white area changed? Again, discuss in class or write your ideas in your journal.

3. In your journal, sketch Mars as you see it in these pictures. Before scientists had cameras to attach to their telescopes, they used sketches like yours to record what they saw, and to guess about what Mars is like.

Galileo's Telescope

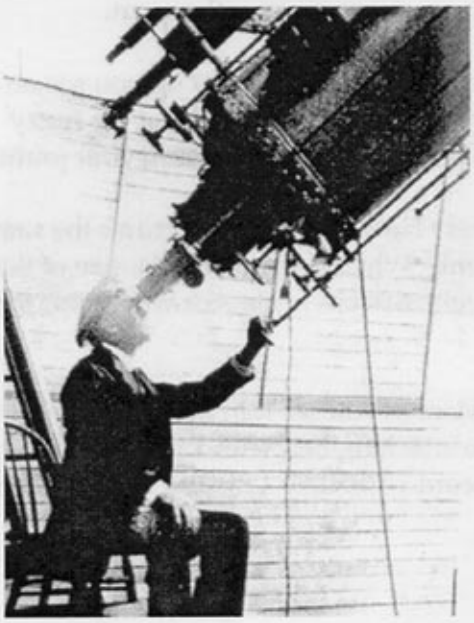
Mt. Palomer Observatory Telescope

Hubble Space Telescope

Scientists Speculate About Mars

Percival Lowell, shown at right looking through his telescope, was convinced that there was life on Mars. He studied Mars with a telescope for many years, and thought he saw canals. He speculated that Martians made these canals to carry melted water from polar ice caps to dry areas of the planet.

Timeline: 1905



For nearly 400 years, scientists used the telescope as their primary means of exploring Mars. At first they made sketches, then they attached cameras to the telescopes, and took pictures. They argued among themselves about what Mars might really be like beyond these fuzzy images.

For example, they looked at the white patches in the pictures, and speculated that there might be large areas of ice, which shrink and grow during the seasons of the Martian year. This is similar to Earth, where the ice fields at the North and South poles also grow and shrink.

Activity: What are your Speculations?

Discuss in class or write in your journal:

- When you look at the telescope pictures, what do you think the surface of Mars is like?
- How do your speculations compare with the scientists' ideas on the next page?

Here are some other ideas people had about Mars:

•There might be life on Mars. Perhaps the dark-light color fluctuations in parts of Mars might be caused by plants responding to seasonal changes.

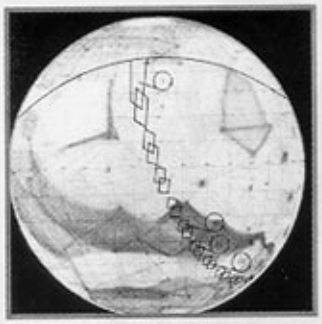
•Mars might have canals, made by Martians, which carry water from the poles to other parts of the planet. Many scientists thought they saw lines on the surface.

•Mars might have a hot core with volcanoes venting gases and spewing lava.

•Mars might be too dry to support life. There might be huge planetary dust storms that can just barely be seen in some images.

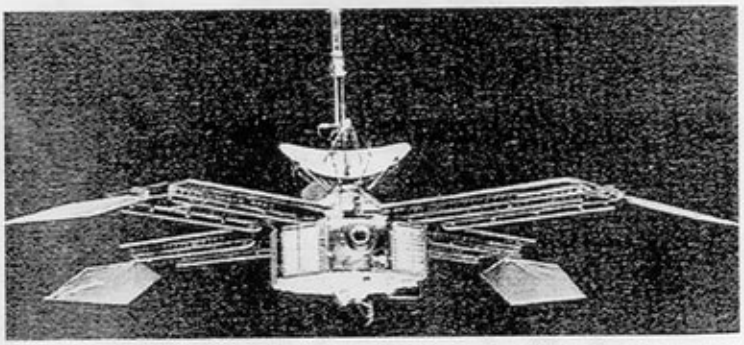
•Mars might be covered with craters, much like the moon.

Mariner 4
The First Spacecraft to Mars



As Mariner 4 flew past Mars, it took 21 pictures, as shown in this map of Mars. The underlying map is based on the best knowledge of Mars before the Mariner fly-by. Now we have much better maps of Mars.

Timeline: 1965

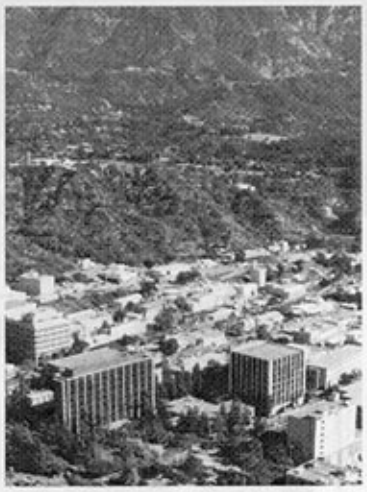


There was only one way to get answers to these questions — send a spacecraft to Mars to get a closer view. This requires careful design of the spacecraft, a video camera and other instruments that can work in space, radio technology to communicate between the spacecraft and Earth, and a powerful rocket that can send the spacecraft such a long way.

These spacecraft have no humans on board, so that once the spacecraft is launched, no one is there to make repairs. Therefore, the engineering and manufacturing must be done carefully.

In 1965, after many tests, and a few failures, NASA succeeded in sending a spacecraft to Mars. The Mariner 4 spacecraft was launched on November 28, 1964, took 7 and a half months to travel to Mars, and arrived at Mars on July 15, 1965.

Mariner 4 did not land on Mars nor go into orbit around it. Mariner 4 just flew past Mars taking pictures as it went. In space exploration, this is called a "fly-by" and is often the first step in exploring a planet. During this fly-by, Mariner 4 took 21 pictures - the first close-up images ever taken of another planet.



Most of the planetary space probes are designed, built and/or managed at the Jet Propulsion Lab (JPL) in Pasadena, California. JPL is responsible for Mars Pathfinder, Mars Global Surveyor and other future missions to Mars. Most of JPL's work is funded by NASA.

Activity: What are those circles?

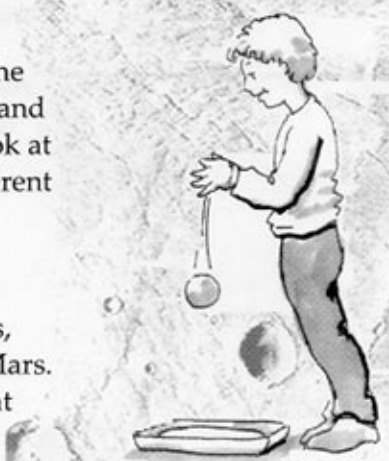
1. Mariner 4 took the picture shown above. Look closely at it. What do you see? What do your think the circles are? Do you see any canals? Based on this image, do you think there is any life on Mars? What new questions does it raise for you?

2. One way scientists try to understand images is to make models of what they see. So, the next step is to try to make a model of the process that you think you see in the image.

3. Spread a layer of dirt across a tray, about 2 cm deep. Also, get some rocks, varying in size from about 1 cm to 5 cm. Moisten the dirt a bit.

4. Spread newspapers on the classroom floor, and put the tray in the center of the newspapers. Hold one of the rocks above the tray and drop it onto the mud. What happens? Remove the rock and look at the pattern. Repeat this with different size rocks, and from different heights.

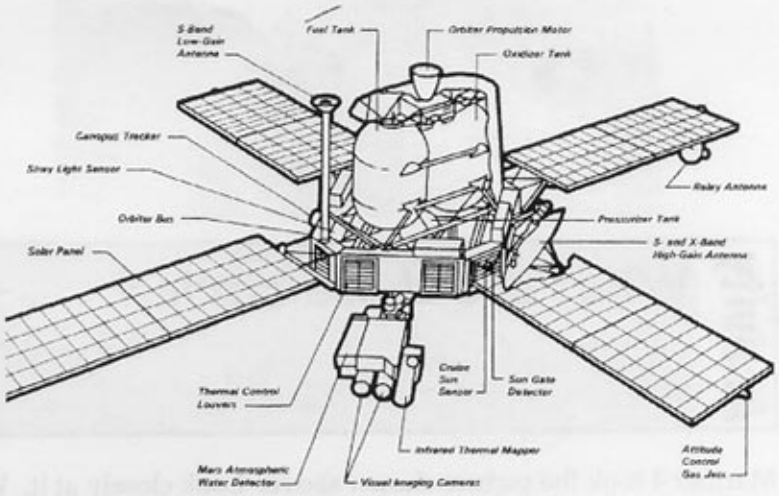
5. Do the shapes look like what you see in the Mariner 4 image? Scientists believe that the circles in the images are impact craters, caused by large rocks (called meteorites) hitting the surface of Mars. When this happened on Mars, the impacts were so powerful that the meteorites were destroyed. How is your model similar to meteorites impacting Mars? How is it different?



Viking Orbiter
Mapping Mars in Detail

Mars scientists study images to learn about Mars. They discuss what they see, compare images, argue about different explanations, and try to reach a consensus about what is going on in the images. They also think about how future missions might help them get more images and data to answer some of the remaining questions.

Timeline: 1976



In 1976, two Viking spacecraft were sent to Mars. The Viking orbiters took thousands of pictures and used a wide variety of instruments to study Mars from orbit. The images were spectacular and enabled scientists to learn a great deal about Mars.

Activity: Studying Viking Images of Mars

On the next few pages are some of the pictures of Mars taken by Viking, showing the tremendous variety of features on the surface of Mars. In this activity, you will study the images, just as the scientists did, and try to figure out what the images show about Mars.

The best way to do this activity is with a group of three or four students working together.

1. Start with image #1, that shows the full planet. Notice how much more detail you can see, certainly more than in the telescope images. Discuss what you see with your teammates.
   - What do you think is the long shape in the middle of the image?
   - What do you think are the circles you see in the left edge?
   - What else do you see?
   - What do you think caused the features that you see?
   - What areas would you like to look at more closely?

2. Remember, you are speculating, just as scientists speculate. You may be right or wrong. That's ok. And just like scientists, your ability to understand these images will improve the more you study the images and the more you learn about Mars.

3. Now look at image #2. Study and discuss the image with your teammates.
   - What do you think caused the circular shapes?
   - Why are some bigger and some smaller?
   - When two circles overlap, which do you think was formed first?
   - What new questions do you have when you look at this image?

4. Continue with the rest of the images, one by one. Study them carefully, and discuss them with your teammates. On the following pages are some sample questions you might think about for each of the images.

5. Now go back to the section called "Scientists Speculate About Mars." Discuss each speculation with your teammates, and try to find evidence in the Viking images to support or refute each speculation. If you are unsure, what additional information about Mars do you need, and how might you get that information?

A Map of Mars

Under each of the images, the location is provided, in terms of Martian latitude and longitude. If you have time and interest, you can use a map of Mars, such as the poster called "An Explorer's Guide to Mars" (which has the latitude and longitude lines), to find where each of the images is located on Mars. Use a pushpin to mark the locations on the map.

Image #1

Sample Questions:

What do you think caused the shape across the middle?

What do you think the circles on the left side are?

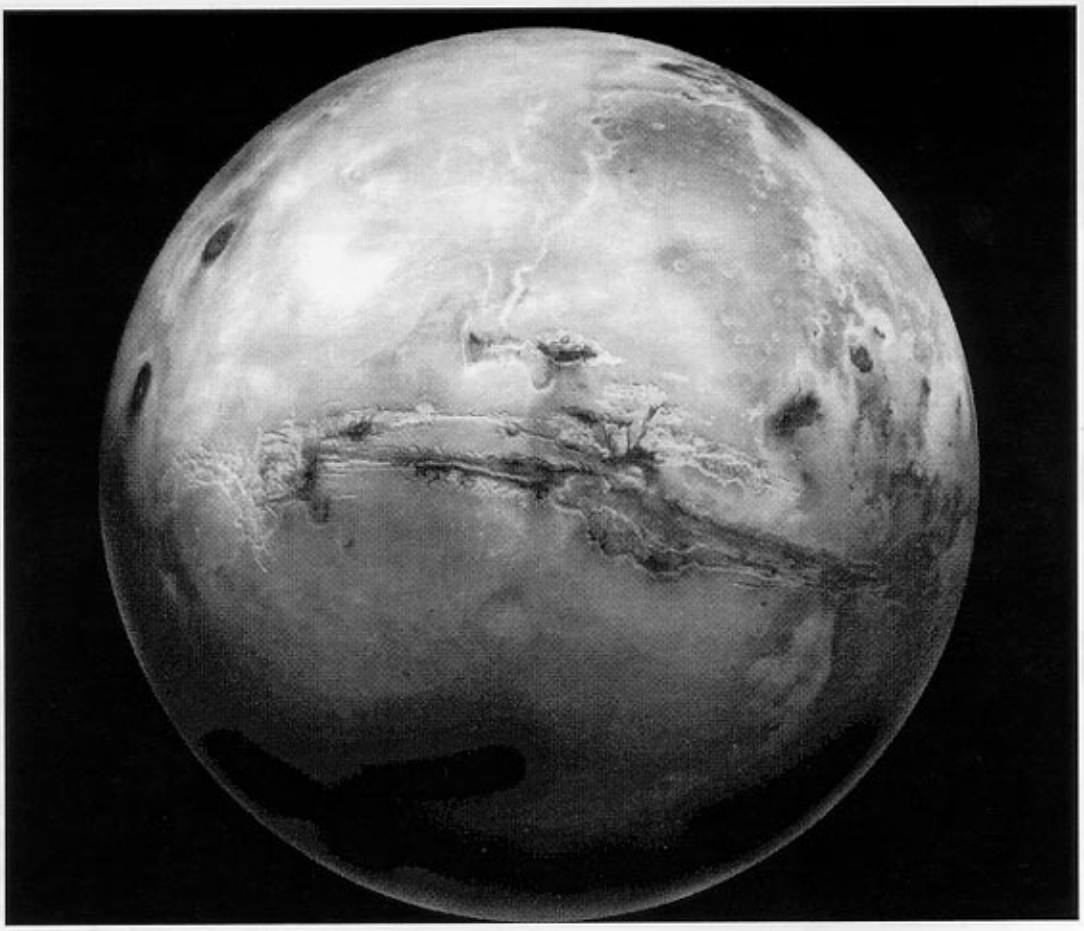
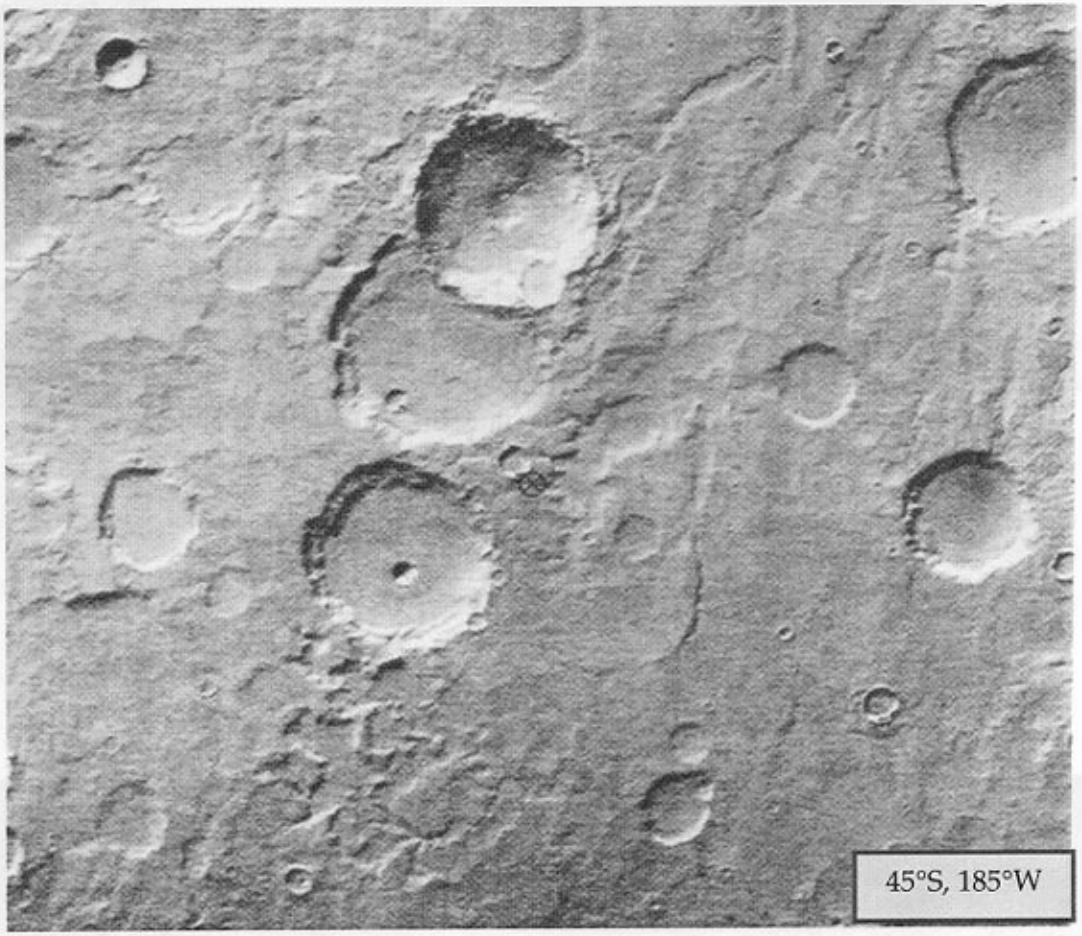


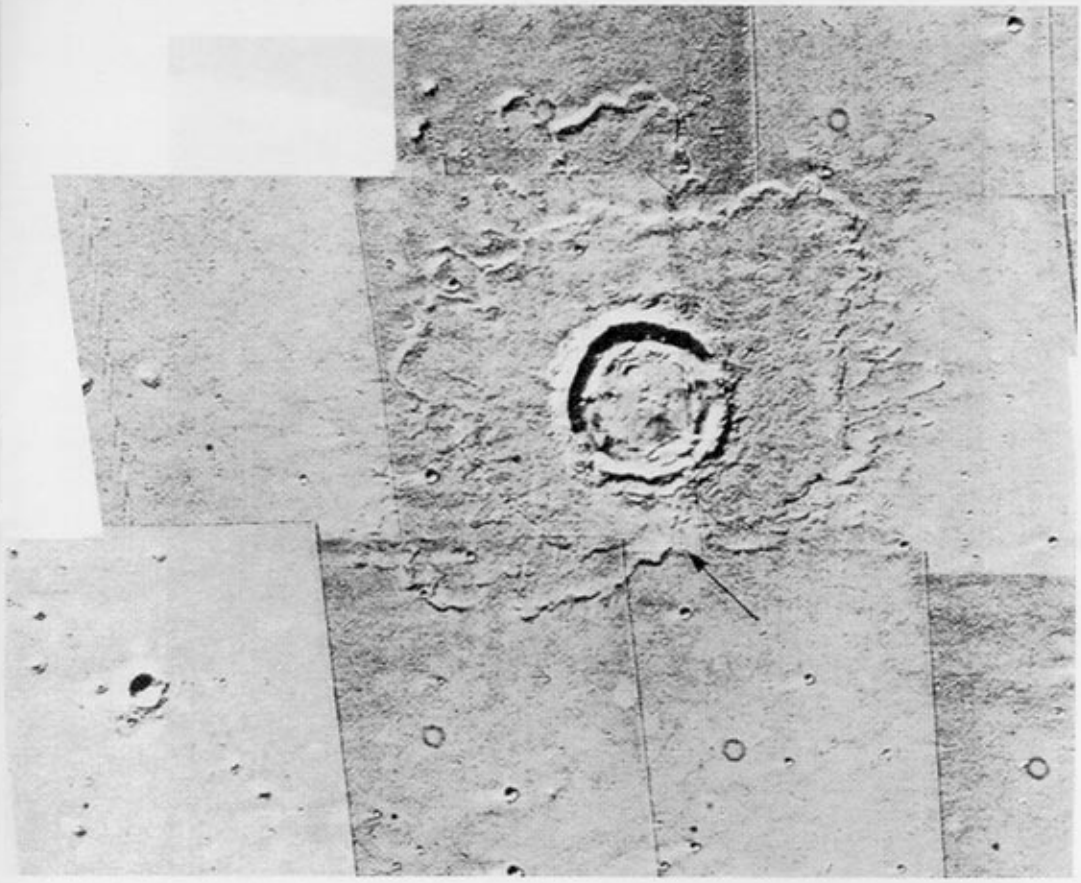
Image #2

Sample Questions:

What do you think the circles are?

Why do you think some of them overlap?





23°N, 40°W

Image #3

Sample Questions:

What do you think caused the strange shape around the circle?

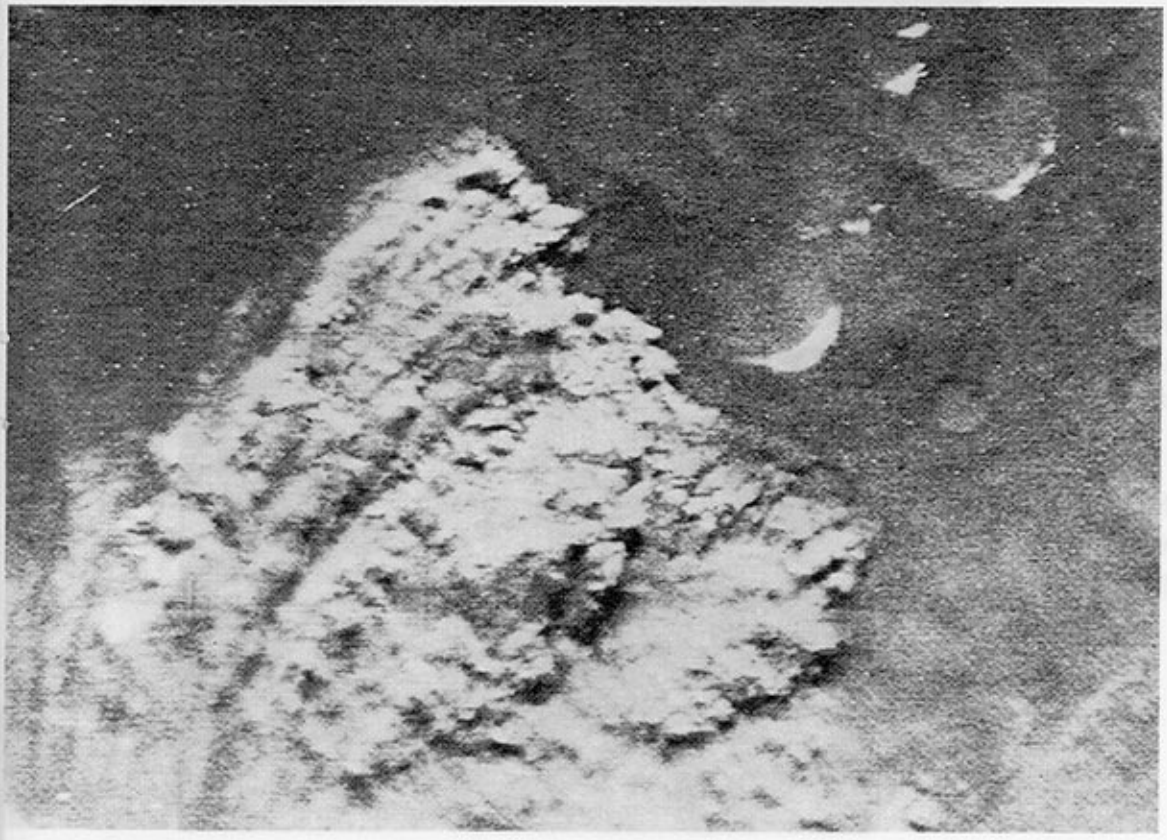


Image #4

Sample Question:

What do you think is going on in this image?

Image #5

Sample Questions:

Can you see Mars' atmosphere in the horizon?

How thick do you think it is?

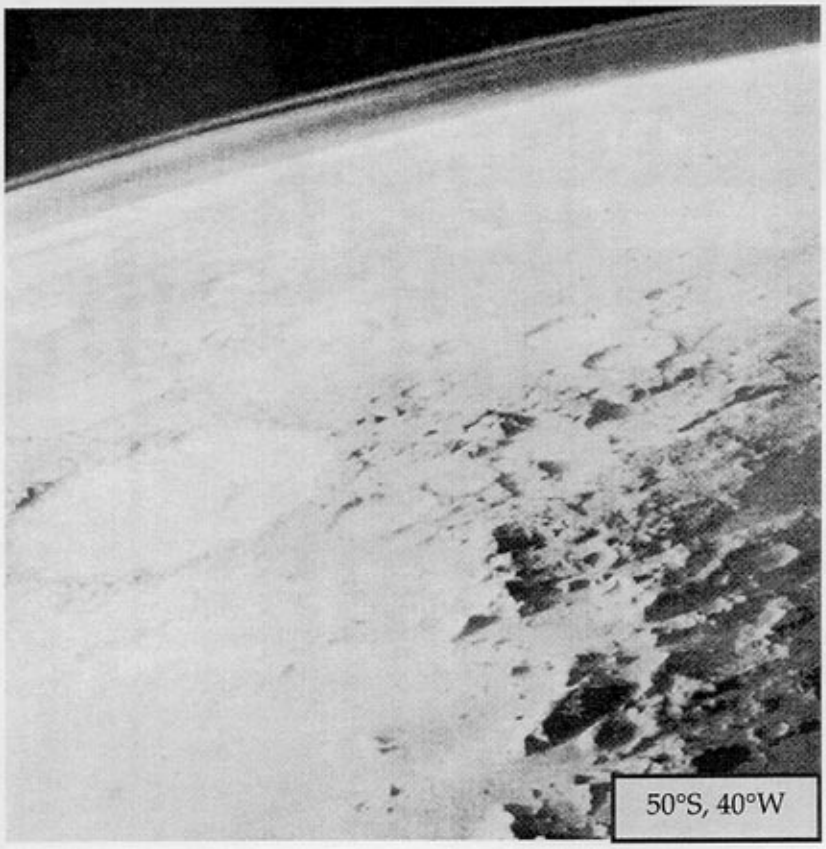


Image #6

Sample Questions:

What do you think caused the mountains in the bottom of the image?

What do you think caused the lines in the top of the image?

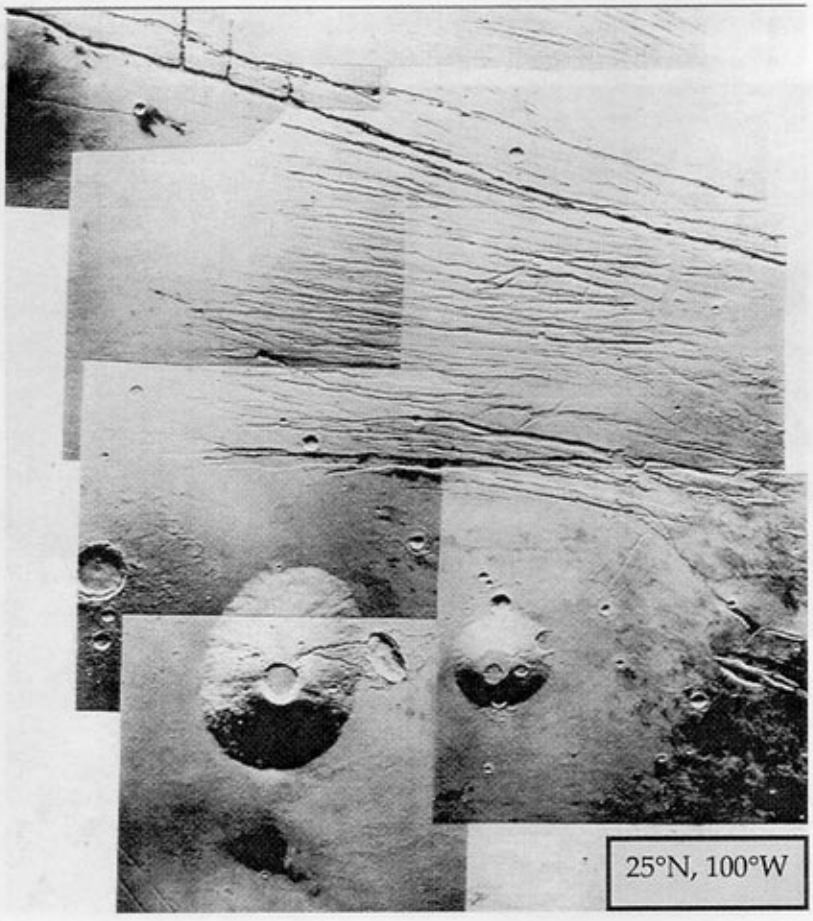


Image #7

Sample Questions:

What do you think caused the valley?

What do you think shaped the cliffs on the edge of the canyon?

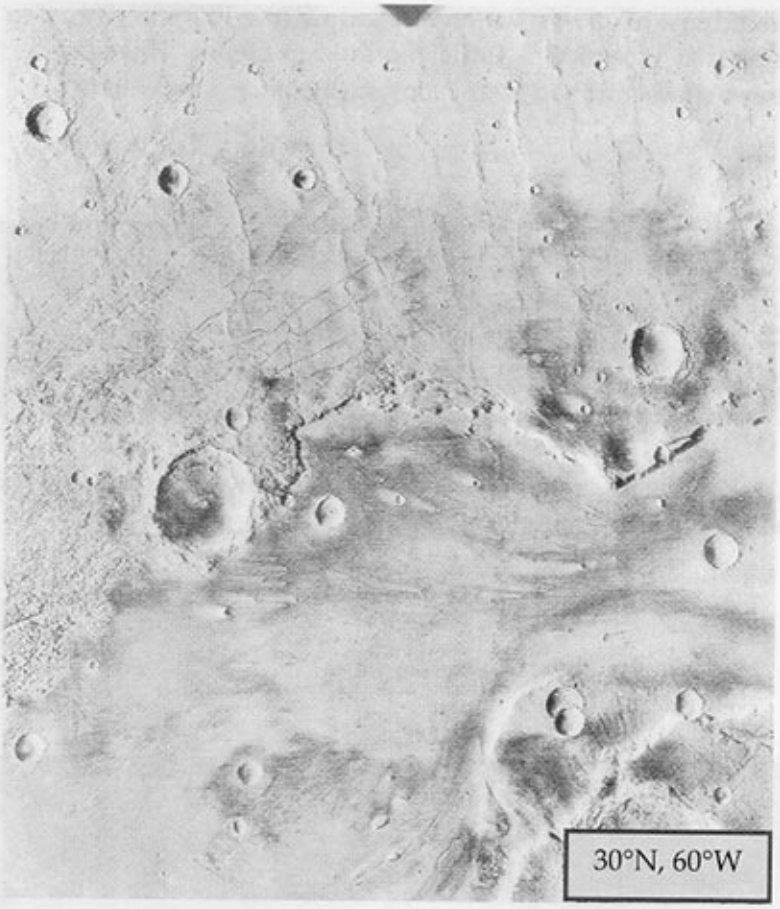


Image #8

Sample Questions:

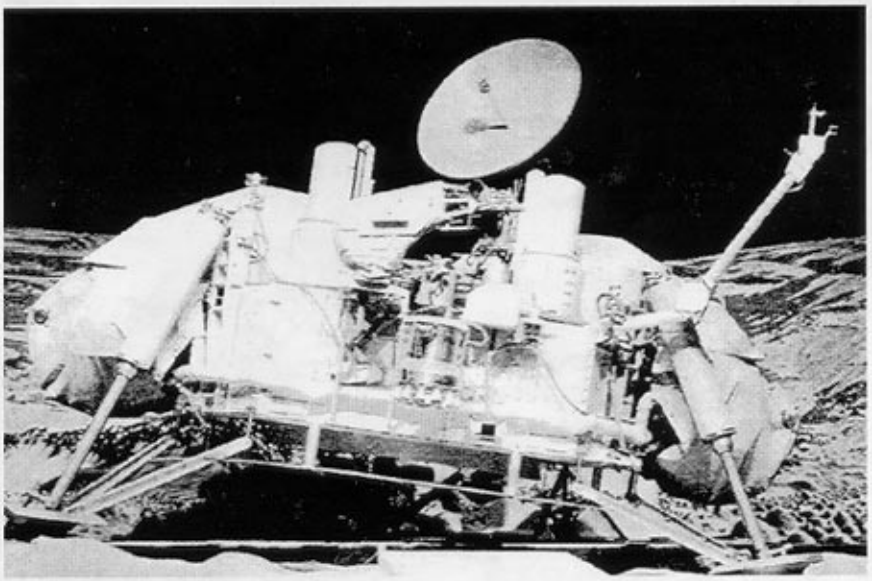
Do you think water might have flowed here?

Why or why not?

What else do you think is going on in this picture?

Viking Lander the First Landing on Mars

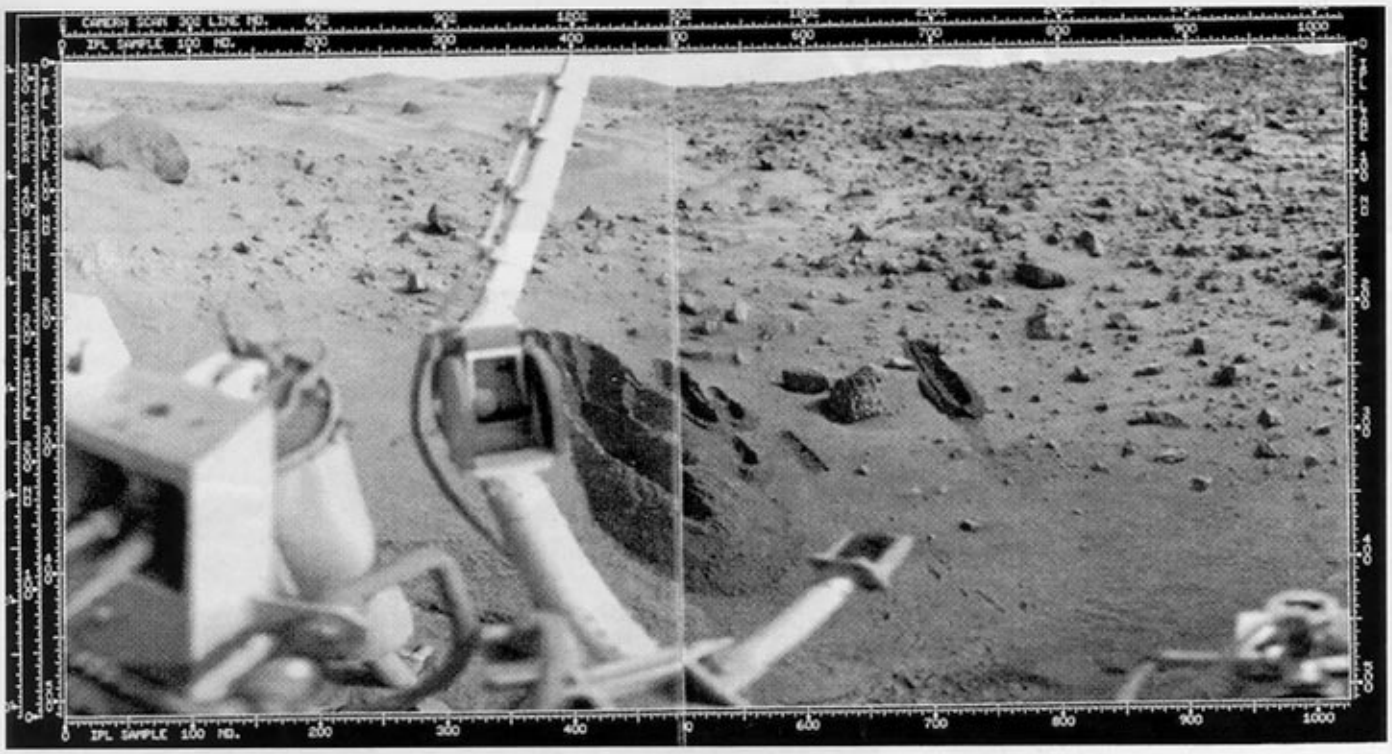
The Viking Lander did an experiment to search for life on Mars. The arm picked up some Martian dirt, and put it in a container on the lander, which conducted some automated experiments. They found no evidence of life at this site. In the picture at the far right, can you see where Viking gouged the dirt for this experiment?



On July 20, 1976, the Viking I Lander, which had flown to Mars linked with the Viking I Orbiter, landed on the surface of Mars. It landed in a relatively flat area called Chryse Planitia. It had to be a flat area to reduce potential landing problems. This was the first time a spacecraft had ever successfully landed on Mars!

Activity: On the Surface of Mars

1. Look at the image on the next page. It shows the surface of Mars, as seen by the Viking camera.



2 Discuss in class or write in your journal:

- What do you see on the surface?
- How big are the rocks that you see?
- Can you see any water?
- Do you see any signs of life?
- Does this look like any place on Earth? Where?

3 Refer back to the images from the Viking Orbiter. Which image shows an area where you think it would be interesting to land another Mars probe? Why? What do you think it would look like?

4 The Viking Lander had a thermometer. On a typical day, the coldest temperature was -85°C, and the warmest was -30°C. Go outside and measure the temperature near your school or home. If possible, measure the warmest temperature during the day, and the coldest at night. Is it warmer or colder on Mars? How much?

5 The Viking lander also had a wind speed sensor. Typical wind speeds on Mars were 5 meters/second (about 11 mph), with gusts up to 25 meters/second (about 56 mph). How does this compare to winds on Earth?

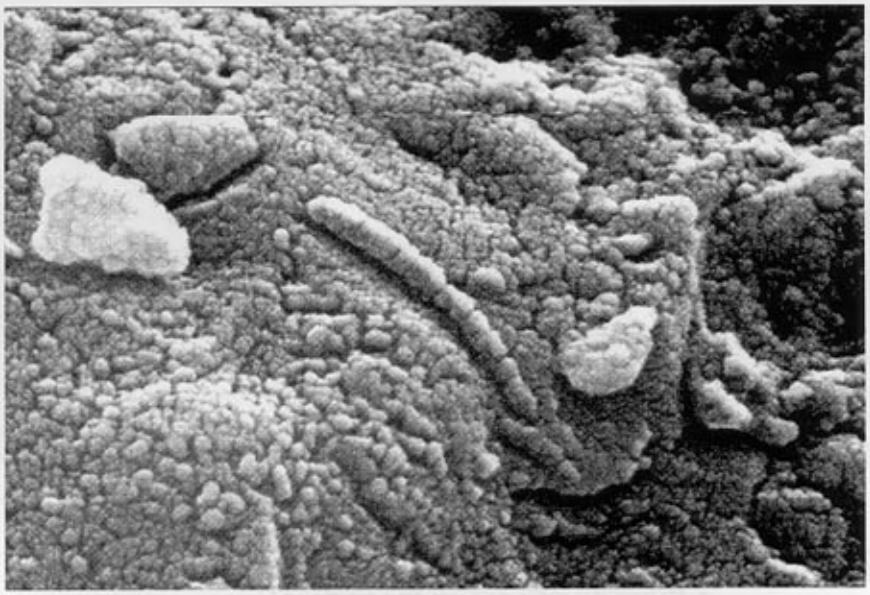
Life on Mars?

Meteorite ALH84001

Meteorites are rocks from space that land on Earth. Most are remains from the early formation of the Solar System. However, there are about a dozen meteorites that scientists believe came from Mars, blasted from its surface when another meteorite hit Mars. ALH84001, shown above, is the Mars meteorite on which scientists found the possible evidence of ancient life on Mars.

The rock was formed on Mars about 4.5 billion years ago, was blasted from Mars' surface about 16 million years ago, and then landed in Antarctica 13,000 years ago. Scientists found it on an expedition to Antarctica in 1984.

These meteorites provide a new way for scientists to learn about Mars.



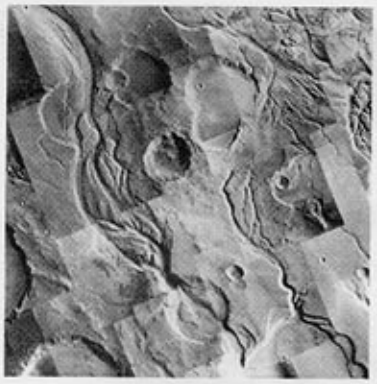
Does this look like life to you? Scientists think this may be the tiny fossil remains of primitive life from ancient Mars. They found this possible microfossil on a rock that was blasted off Mars millions of years ago, traveled through space and landed in Antarctica. If further study confirms these research findings, then this will be the first evidence of life on another planet!

NASA scientist Dr. David McKay and his colleagues first examined the rock with advanced equipment and found possible chemical evidence of past life. Then they used a very powerful electron microscope and saw the image above (the possible fossil is smaller than a human hair).

Further study is required, and scientists have not yet found any evidence for current life on Mars. However, the possibilities presented in this new discovery are very exciting! They are focusing a lot of public and scientific attention on Mars exploration, and enabling NASA to rethink its Mars exploration strategy, to focus more on the search for evidence of past or present life on Mars.

Activity

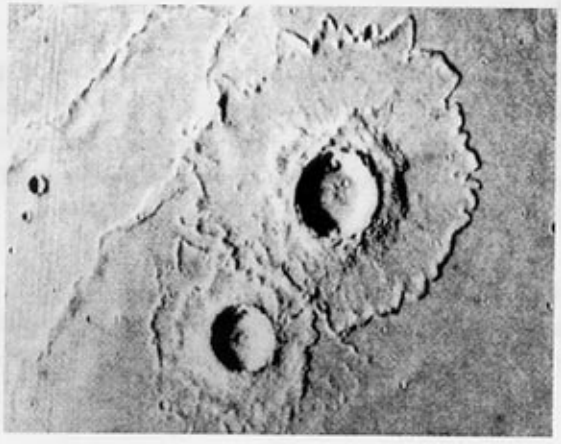
Water on Mars?



Searching for past or present life on Mars is closely related to the search for past or present water on Mars.

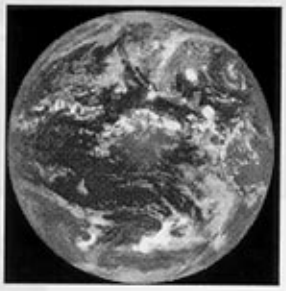
1 Evidence of ancient surface water

Look at the images above. Scientists believe that early in Mars' history, water flowed on the surface of Mars. Do you see any evidence of flowing water?



2 Evidence of sub-surface water

Mars probably has ice and even liquid water below its surface. If there is ice below the surface, it might melt when the surface is hit by a meteorite. Look at the image above. Do you see any evidence that sub-surface ice melted when this crater was formed?



On Earth, water is essential for life. The water cycle (with clouds, rain, rivers, lakes, oceans and evaporation) keeps water flowing throughout the Earth's systems. The earliest forms of life started in the oceans. And think what your life would be like with no water!

We don't know how important water is for life on other planets, but searching for evidence of past or current water seems to be a good place to start in our search for life on Mars.

Returning to Mars

It has been 20 years since the historic Viking missions. Now it's time to return to Mars, with a new and advanced series of orbiters and landers. There are hundreds of people involved in preparing these Mars missions. Let's meet one person.

Donna Shirley is Manager of the Mars Exploration Program Office. She has overall responsibility for the decade-long series of Mars missions. Mrs. Shirley is a manager and an engineer who has worked at NASA JPL for 27 years. She has been involved with other planetary missions including the Mariner X mission to Mercury and Venus and the Cassini Mission which will be launched in 1997 to explore Saturn. She has a daughter who is a sophomore in college.

Asked why she was so excited about the Mars missions, she said,

"The Mars missions will provide us with a marvelous opportunity to answer so many important questions about Mars. It will help us learn about Mars' history, about whether it once had liquid water on its surface and maybe life."

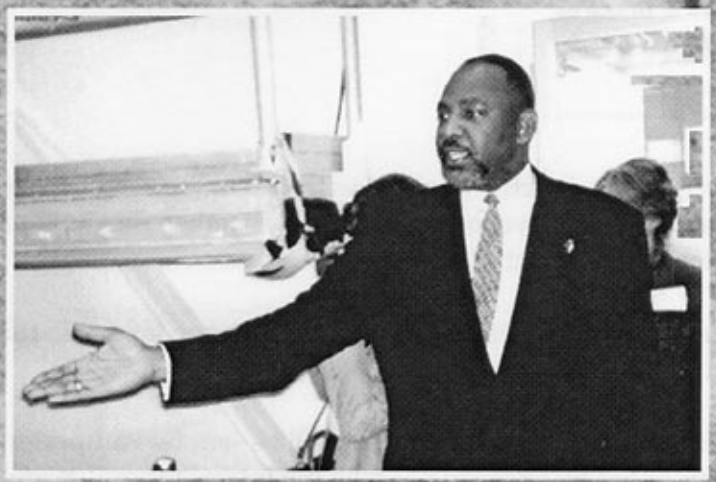
Asked why she wanted to have students so closely involved with these Mars missions, she said,

"I would like people to spend more time watching the real stuff from Mars than they do watching Star Trek."

Mike Malin designed the camera on the Mars Global Surveyor

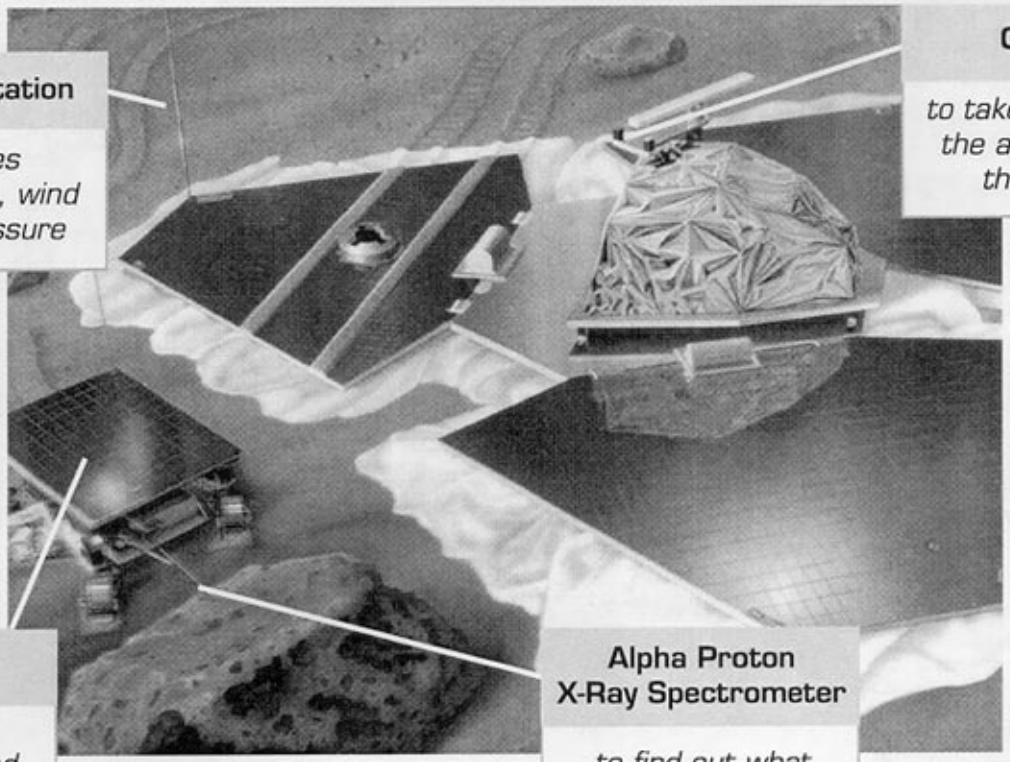
Matt Golombek is the Chief Scientist for Mars Pathfinder

Arden Albee is the Chief Scientist for Mars Global Surveyor



Cheick Diarra is Manager of Mars Education and Public Outreach

Mars Pathfinder



Weather Station

measures temperature, wind and air pressure

Camera

to take pictures of the area around the lander

Sojourner

a rover to explore around the landing site

Alpha Proton X-Ray Spectrometer

to find out what elements the Martian rocks are made of

You will be directly involved with two up-coming missions to Mars. Mars Pathfinder is a lander, and Mars Global Surveyor is an orbiter. Together, they will provide you and scientists with a lot of new information about Mars.

Mars Pathfinder was launched in December 1996, will travel for seven months, and will land on Mars on July 4, 1997.

After it lands, images and data will be sent by Pathfinder to NASA JPL, and then some of them will be distributed by television and by the Internet World-Wide Web. If you have a computer and Internet connection in your school or home, you will be able to see the pictures of the landing site, within minutes, hours or days.

You may want to make a model of the landing site in your classroom, based on what you see in the images. You also will see the pictures taken by the Sojourner robot, as it wanders around the landing site. This will help you with your classroom model of the landing site.

You also will get data from the weather station. You will be able to see how cold it is on Mars, how the temperature varies hour by hour, and from one Martian day to the next (Martian days are called "sols" and are about 24 hours, 29 minutes long).

Sojourner named by a 12-year old student

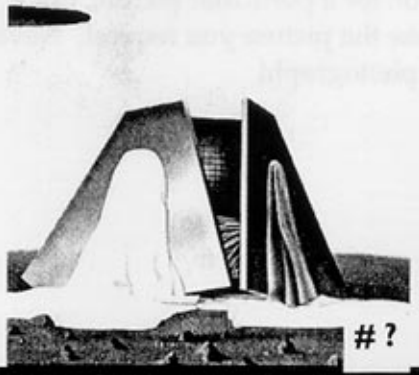
In a contest sponsored by the Planetary Society to name the Pathfinder rover, the name "Sojourner" was selected to honor "Sojourner Truth", a 19th century African-American abolitionist and champion of women's rights. The name was proposed by Valerie Ambrose, a 12 year old girl from Bridgeport, Connecticut.

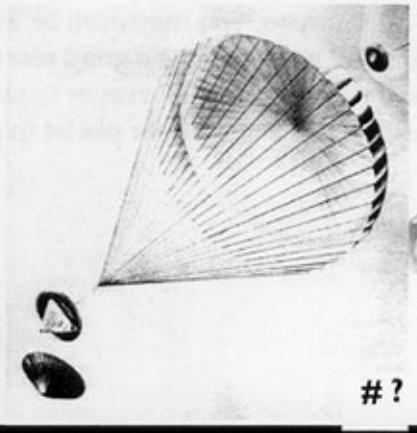
Activity

How Mars Pathfinder will land and explore Mars

The Mars Pathfinder is an engineering experiment. It is exploring new ways to land on Mars and testing technology of the remote-controlled rover

Look at these images. See if you can figure out the correct sequence, and what is going on in each stage.



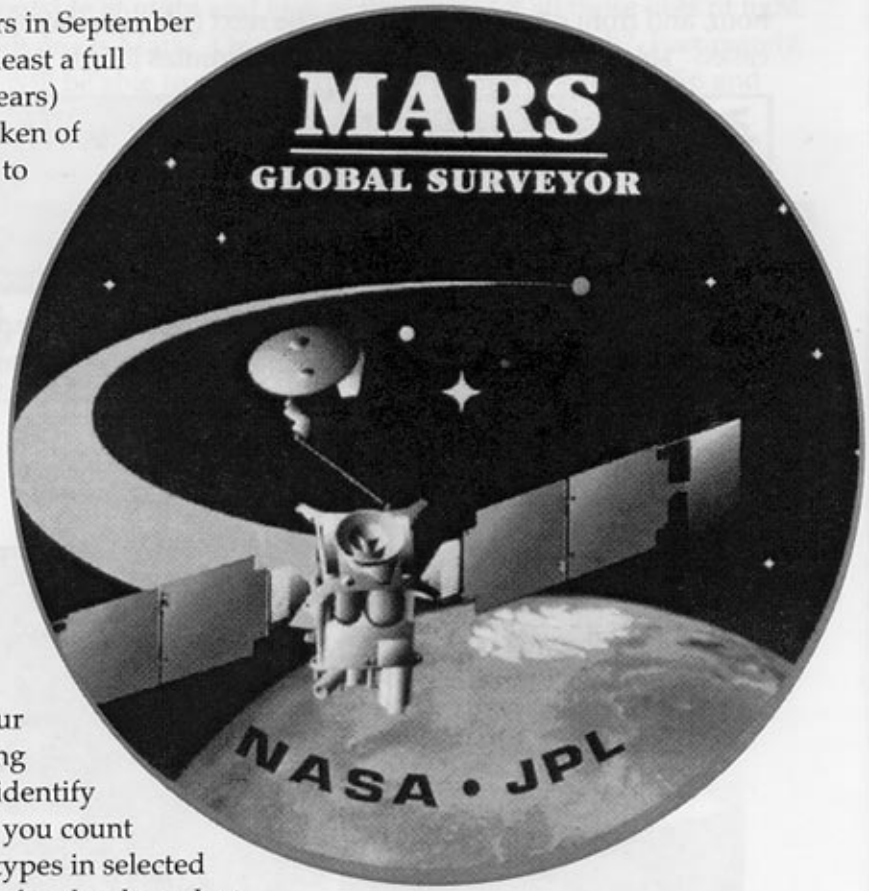


Find out more about Pathfinder on the web

http://mpfwww.jpl.nasa.gov

Mars Global Surveyor

Mars Global Surveyor will arrive at Mars in September 1997. It will go into orbit, and spend at least a full Mars year (687 days, nearly two Earth years) taking the most detailed pictures ever taken of the surface and using other instruments to learn more about Mars.

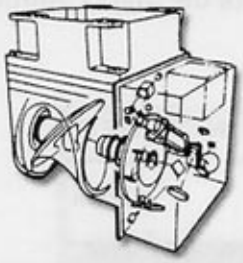


Every week, the scientists will release a set of the latest pictures, for you and other students to help you learn more about Mars and to use in your own investigations. The pictures will shows Mars' craters, volcanoes, dust storms and other geological and atmospheric features.

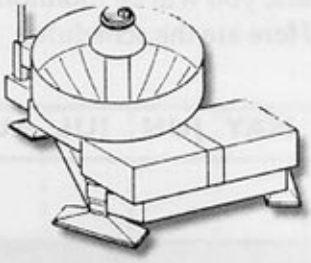
Some scientists may ask you to help them in their research. There will be so many pictures (thousands) coming back from Mars that scientists might need your help in looking through and documenting some of them. They might train you to identify different types of craters, and then have you count how many craters there are of different types in selected images. Or they might want you to look for clouds or dust storms in the pictures. You will do real science research with these scientists.

If certain areas of Mars especially interest you, you may even be able to request that the Mars Global Surveyor take pictures for you. You will need to have a good reason for a particular picture, but if you do, NASA may send the request to the Mars Global Surveyor to take the picture you request. Never before have students been able to select areas of another planet to photograph!

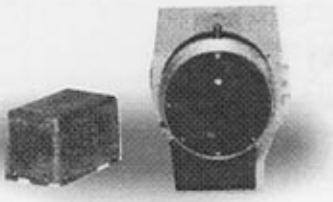
Science Instruments on Mars Global Surveyor



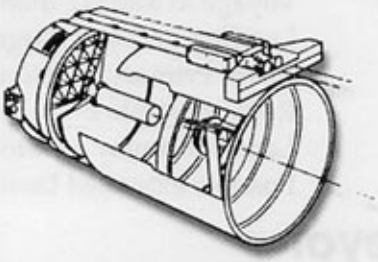
Thermal Emission Spectrometer
to measure & map heat emitted by Mars



Laser Altimeter
to measure the heights of Mars' physical features

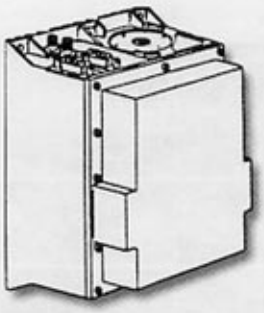


Magnetometer and Electron Reflectometer
to study Mars' magnetic fields



Mars Orbital Camera to take wide angle and close-up pictures

Mars Relay Radio System
To relay messages from landers



Radio Science Investigation
to study Mars' atmosphere and gravity

As a child, Ken Edgett loved to read science fiction stories about Mars exploration. Now, as a Research Associate at Arizona State University, he helped build the Thermal Emmission Spectrometer which will go to Mars on Mars Global Surveyor. He also is Director of Arizona's K-12 Mars Education Progam, and Editor of the Mars Underground News. His dreams of exploring Mars are coming true.

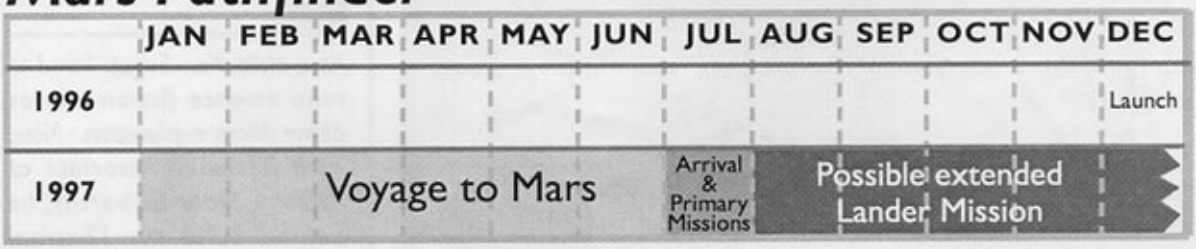
Find out more about Mars Global Surveyor on the web

http://mgs-www.jpl.nasa.gov/

Getting Ready for YOUR Mars Missions!

Over the next several months and years, you will be monitoring the progress of the Mars Pathfinder and Mars Global Surveyor missions. Here are the schedules:

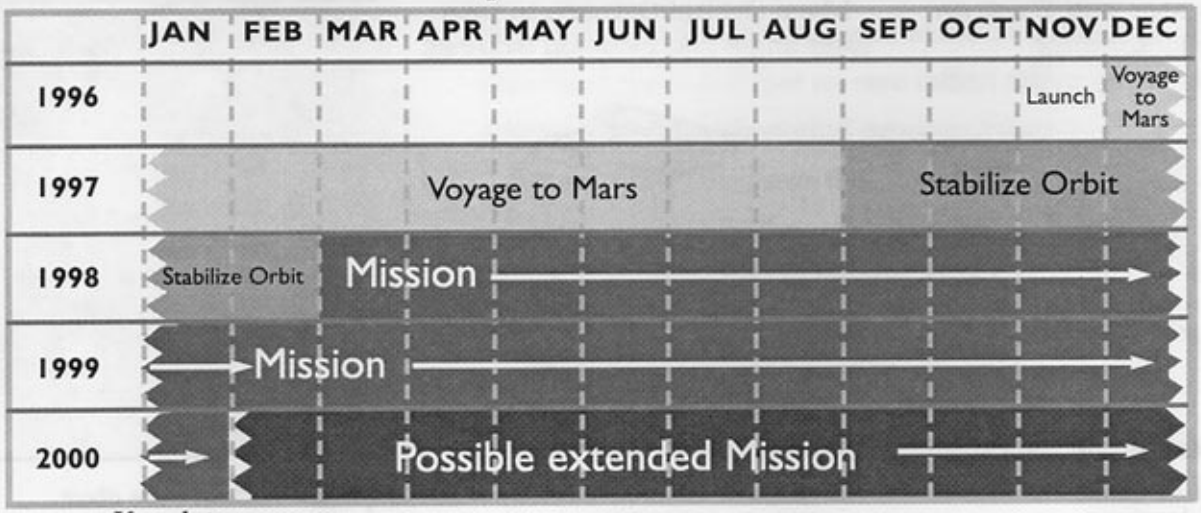
Mars Pathfinder



Key dates:

Dec 4, 1996	Launch
Dec 1996 to July 1997	Voyage to Mars (7 months)
July 4, 1997	Landing on Mars (target date)
July 1997	Rover Primary mission (1 week)
	Rover possible extended mission (1 month)
	Lander Primary mission (1month)
Aug 1997 to ??	Possible extended Lander mission

Mars Global Surveyor

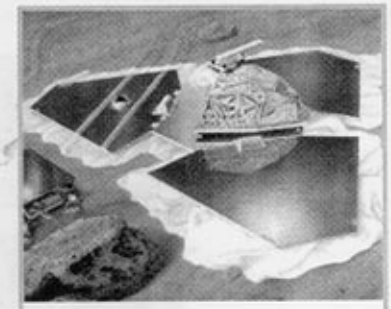


Key dates:

Nov 6, 1996	Launch
Nov 1996 to Sep 1997	Voyage to Mars (10 months)
Sep 1997	Arrival to Mars orbit
Sep 1997 to Feb 1998	Stabilize orbit (7 months)
Mar 1998 to Feb 2000	Primary mission (687 days = one Mars year)
Mar 2000 to ??	Possible extended mission

Activity

How will you get ready?



Mars Pathfinder

Mars Global Surveyor

These dates may seem a long time from now. However, there is a lot of preparing you need to do. For example, you need to learn more about Mars, about the instruments on Pathfinder and Mars Global Surveyor, and about how you will get the live data and images in your school or home.

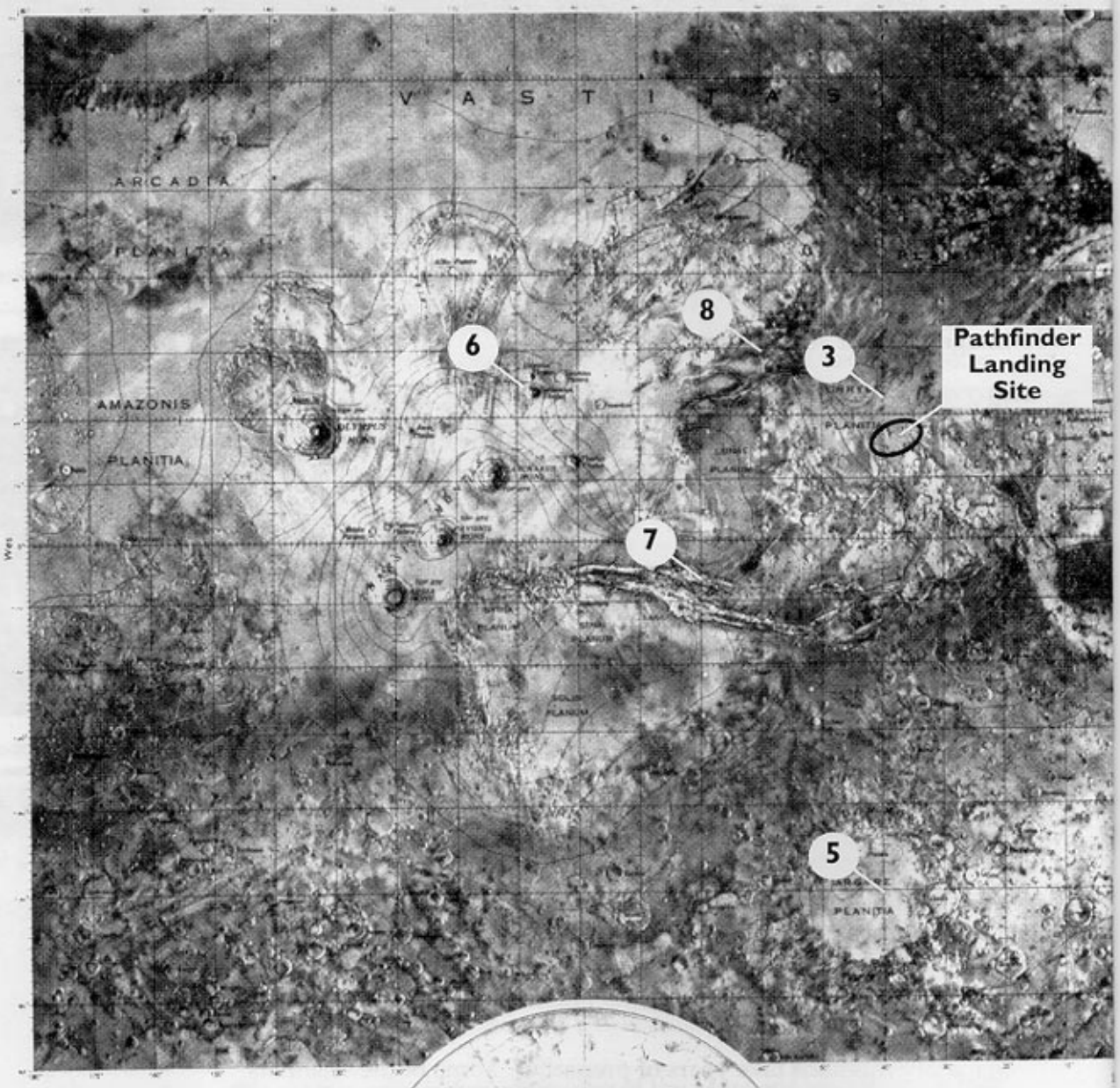
1. In your class, put a timeline on the wall, showing the months from now until June 1998. On the calendar, mark the events listed above. Then during the year, cross off each month as we get closer to launch, travel and arrival dates.

2. Discuss with your teacher what other Mars activities you will do during this school year to learn about Mars and monitor the progress of the missions.

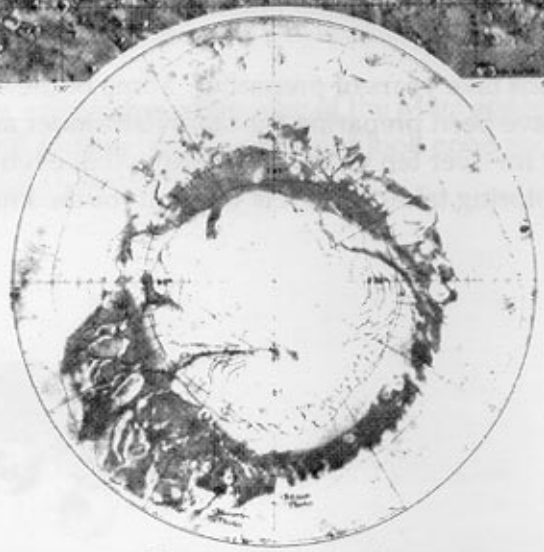
3. Mars Pathfinder lands on July 4, 1997. Within a few days of this date, you will start seeing new pictures of the surface of Mars, and the Sojourner robot will begin exploring the surface. Will you have access to a computer and the Internet to get the new data and images?

4. Mars Global Surveyor will begin to send pictures from Mars orbit in March, 1998. Where might you be? Talk with your teacher about whether your next year's teacher will continue with the Mars program that you are starting now.

Planetary missions take years of preparing. Some of the scientists and engineers have been preparing for Mars Pathfinder and Mars Global Surveyor for over ten years. They know that even though learning and exploring takes time, it is worth it for the knowledge gained.



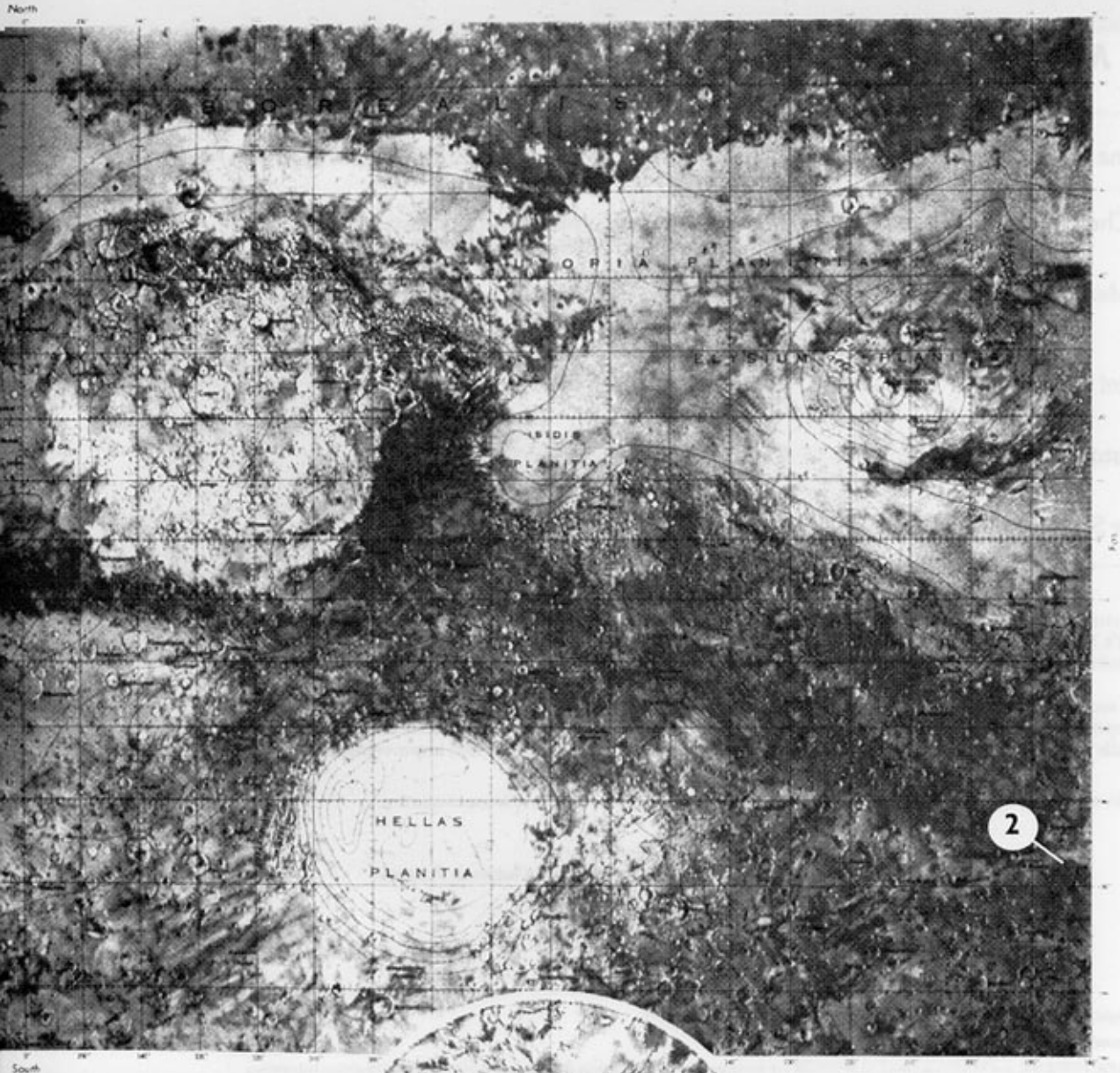
scale at equator: 60 km/mm



North Polar Region

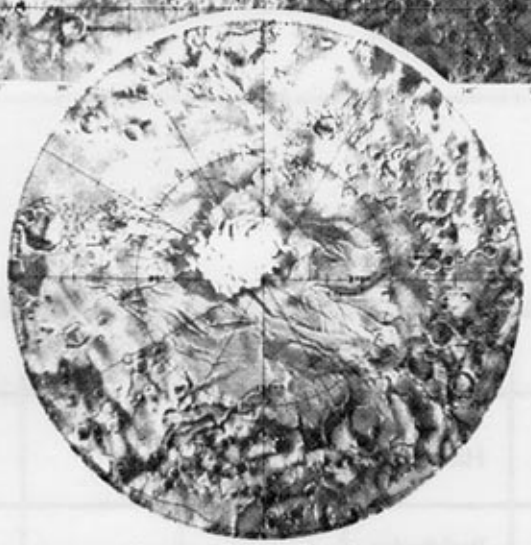
Map

Numbers refer to



f Mars

photos on pages 22-25



South Polar Region

Mars Exploration Education and Public Outreach Program

Donna Shirley	Manager, Mars Exploration Program (NASA/JPL)
Dr. Cheick Diarra	Manager, Mars Exploration Education and Public Outreach Program (NASA/JPL)
Dr. Meredith Olson	Mars Exploration Program Educator (Seattle Country Day School)
Daniel Barstow	Project Director (TERC)
Christopher Randall	Curriculum Developer (TERC)
Hope Schauer	Illustration and Layout

These curriculum materials were developed for JPL's Mars Exploration Education and Public Outreach Program, which is part of NASA's Mars Exploration Program. The work is funded by NASA's Jet Propulsion Laboratory (JPL) which has the overall responsibility for the Mars Exploration Program.

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 information about materials or the Mars Exploration Education Program please contact:

Dr. Cheick Diarra
Mars Exploration Education and Public Outreach Program
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
818-354-6111

Module Titles	Getting Started	Grand Canyon of Mars	Pathfinder Landing Site	Volcanoes	Mars Pathfinder	Mars Global Surveyor
TEACHER MATERIALS	Teacher's Guide	Teacher Handbook	Teacher Handbook	tba	tba	tba
STUDENT MATERIALS	Student Guidebook	Grand Canyon of Mars Image Set	Pathfinder Landing Site Image Set	tba	tba	tba

Version 3.2 Fall 1996