APPENDICIES

Appendix Activity #1

Make Scale Models of the Planets

By making models of each planet at the same scale, students see how the planets compare in size.

Appendix Activity #2

Make a Model Solar System

In this activity, students learn about the organization and scale of the solar system. Students make a model of the solar system using the same scale they used for the planet models in Appendix Activity 1. When people see a solar system model in which both the sizes and distances of the planets from the Sun are at the same scale, they are usually surprised by how small and far apart the planets are!

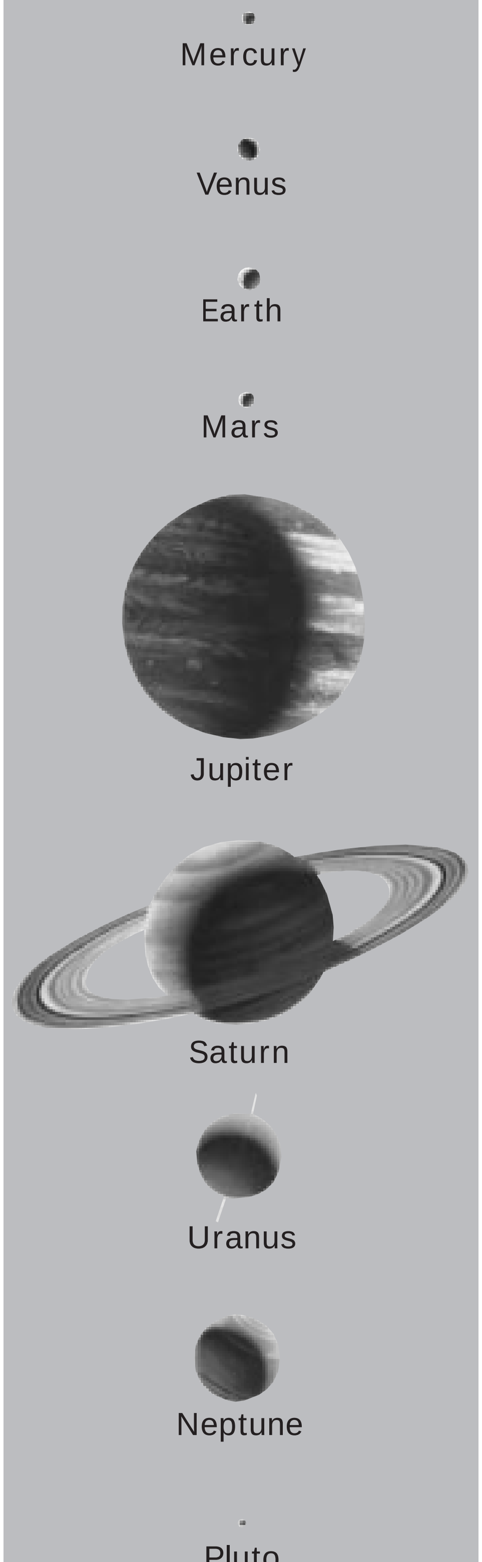
Appendix Activity #3

Find Mars in the Night-time Sky

When ancient astronomers noticed that Mars moved slightly from one night to the next, they considered it a special "star." If the timing is right, your students will be able to see Mars in the night-time sky. If they observe it over a few weeks, they too will notice that it moves. This activity enables your students to know where and when to look for Mars.

APPENDIX ACTIVITY 1: MAKE SCALE MODELS OF THE PLANETS

THE PLANETS & THEIR REALITIVE SIZES



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 this activity, you will make models of the planets, in order to compare their sizes.

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 scale models that are one billion times smaller than the real planets.

Sizes of the Planets

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 it is rounded off to the nearest tenth of a centimeter). 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 Repeat Step 1 with 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 will be too small to label).*

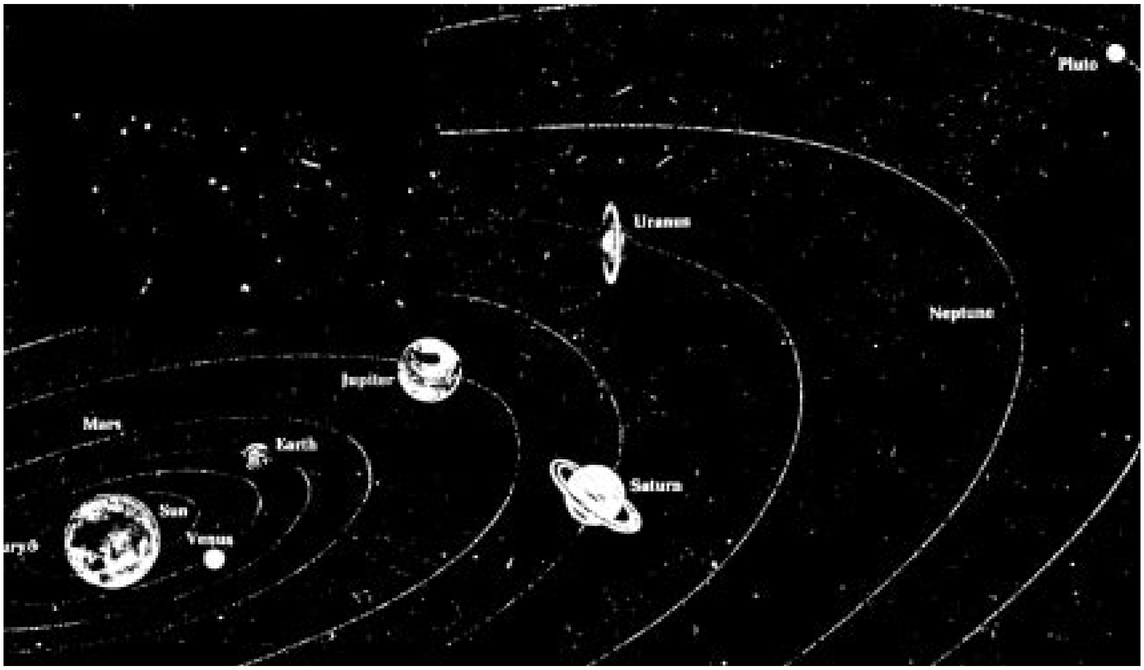
3 After you cut out all the planets, glue or tape them into your journal. One student in the class should set aside the paper planets and not glue them to his or her journal. You will need them for the next activity.

4 Finally, make a scale model of the Sun. Tape several pages of newspaper together and cut out a circle that is 139 centimeters in diameter. 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?

APPENDIX ACTIVITY 2:
Make a Scale Model of the Solar System



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.

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 Referring to the data table on the left of this page, look at the actual distance from the Sun to the Earth and 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 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. 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.

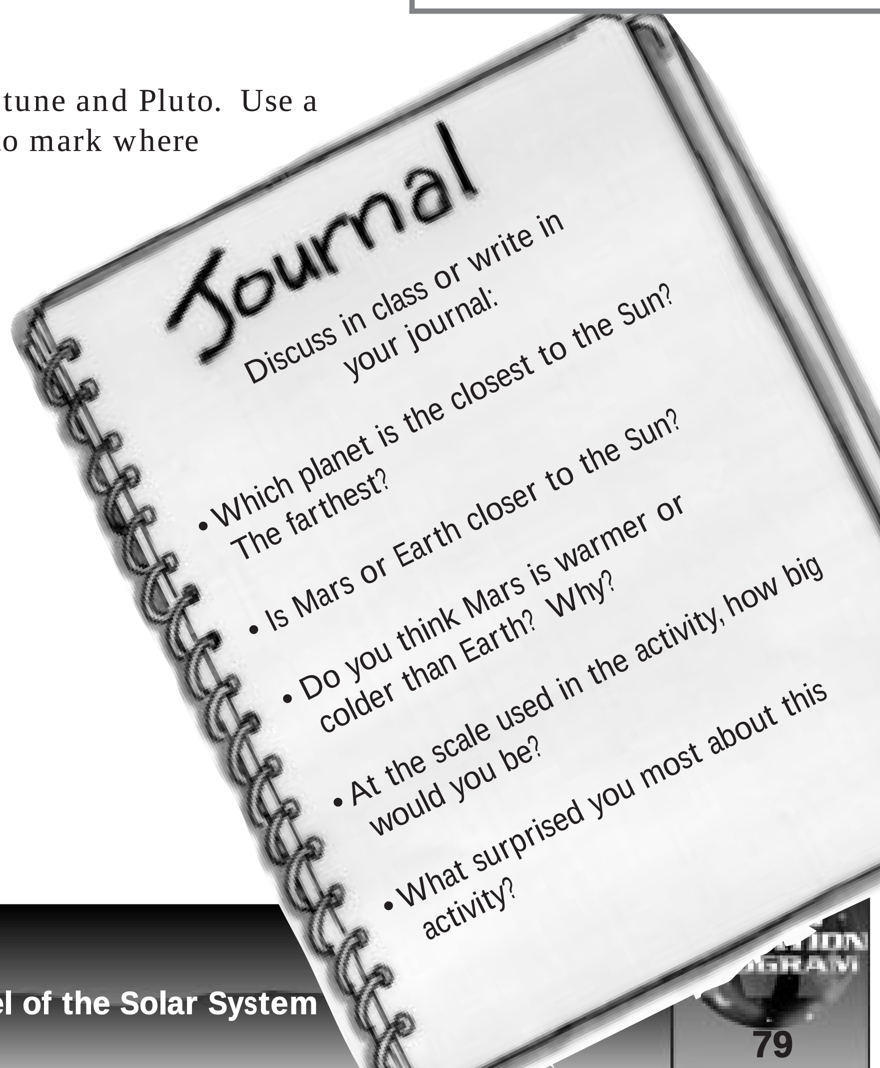
6 The outer planets are even farther away. In fact, they are so far away in this scale model that they will probably not fit on your school property. Try Jupiter.

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

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



APPENDIX ACTIVITY 3:
Find Mars 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 nine "wanderers."

PART A

Mars is a Wanderer in the Night-Time Sky

Look at the two pictures on below. 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. How might you explain this difference?

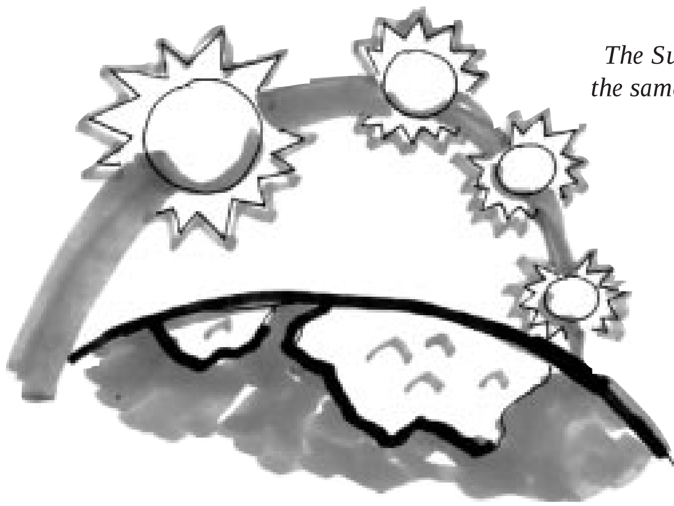
May 1, 1996

May 8, 1996

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? Here is how to know where to look.

PART B

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** — Since the rise time changes constantly, you need to find an up-to-date information source such as an astronomy periodical. Current information can also be found at Web sites such as *Planet Finder*: http://www.cal-web.com/~mcharvey/planet_all.html

Where Do I Look?

To find out exactly where in the sky to look to see a planet, visit Solar System Live, a Web site that provides a planet's coordinates for any time or day.

http://www.fourmilab.ch/solar/solar.html

Enter your "Time" and "Observing Site" information. Then, hit "Update." The two numbers you need are:

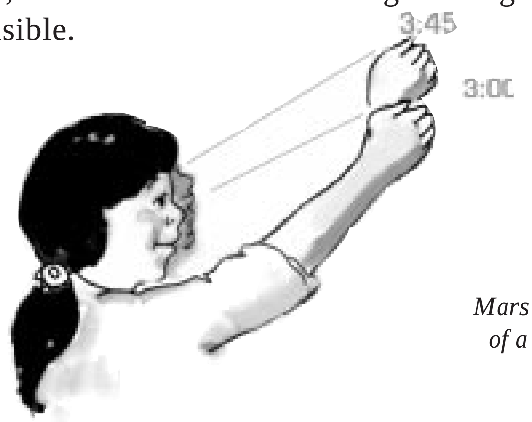
***Altitude**, the number of degrees above or below the horizon.*

***Azimuth**, the local compass bearing to the planet at your site.*

Hit "Ephemeris" for a glossary of terms

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

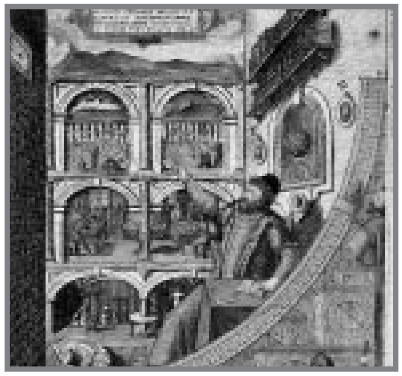
5 **If you look after "Mars rise time"** — Mars will move across the sky following the same band as the sun (the ecliptic). It will take about six hours from the rise time until Mars reaches the highest point in the sky. So, you have to figure out how far along the ecliptic to look. Here's an easy way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

Web Tip

To find sources for planetary facts, rise times, and general information, type "planet finder" (including quotes) into the query box of a Web search engine.

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 Valles I-1618
Map of Eastern Valles Marineris to Ares Valles 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

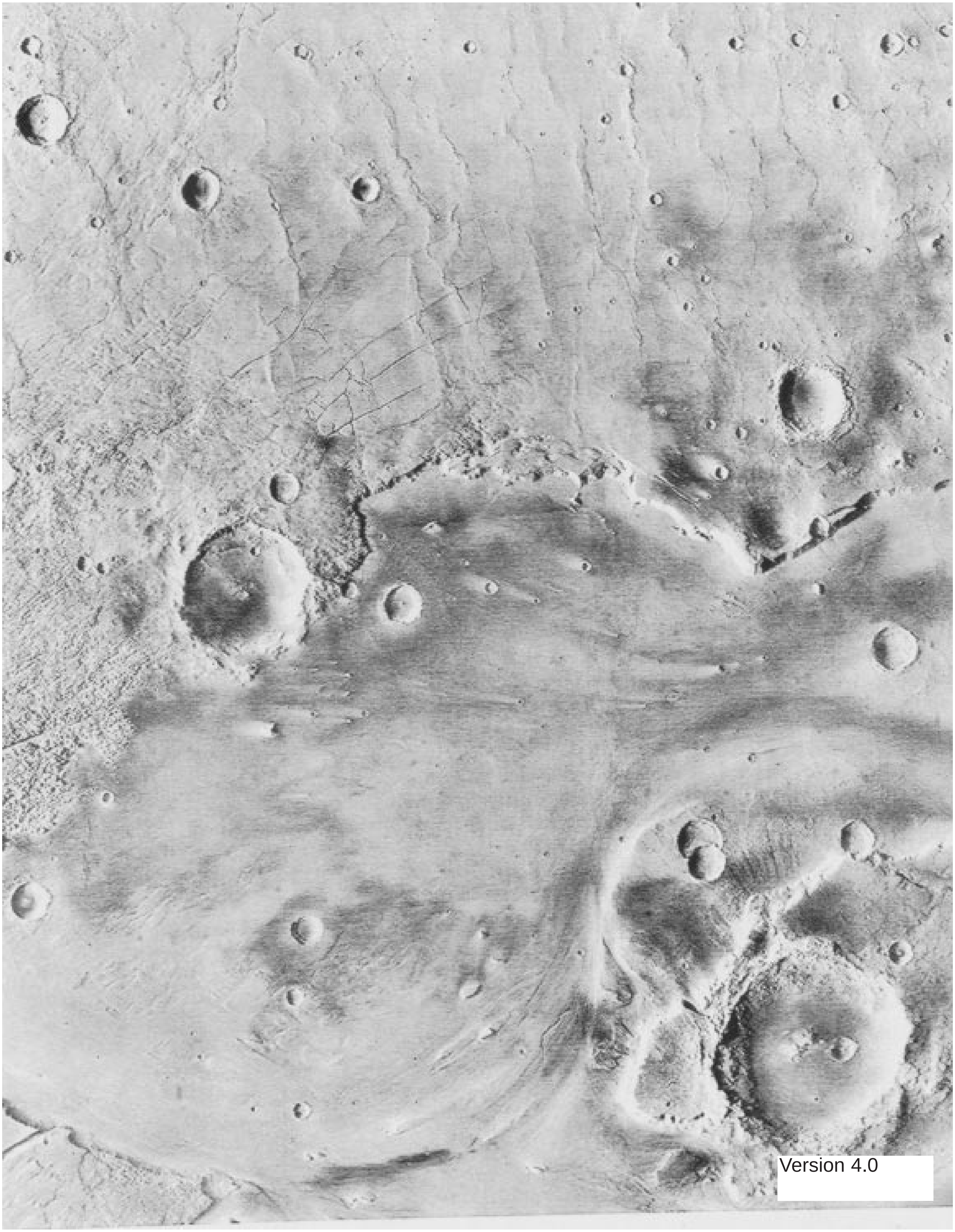
Floods

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

Pathfinder

Map of Ares Valles 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



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