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Mars-Earth Geographical Comparisons: A Pictorial View

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MARS-EARTH GEOGRAPHICAL COMPARISONS:
A PICTORIAL VIEW

by
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ABSTRACT

This publication is a collection of pictorial comparisons of prominent physiographic features found on Mars and Earth, consisting of equal-scale side-by-side pairs or cartographic overlays. Martian features compared with terrestrial ones include Valles Marineris, the Tharsis bulge, Olympus Mons, the Hellas and Argyre basins, areas of catastrophic flooding, and the polar regions. The illustrations are accompanied by a brief descriptive text and bibliography.

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MARS-EARTH GEOGRAPHICAL COMPARISONS: A PICTORIAL VIEW

INTRODUCTION

Mars is a planet that has fascinated mankind for centuries. The earliest telescopic observations revealed the polar caps and dusky markings on its ruddy surface and led to speculation that Mars might be an Earthlike world. This thinking culminated in the late 19th and early 20th Centuries with the great "canal controversy." Some astronomers of the time, notably Percival Lowell, stated that fine lines observed by them on the Martian surface were actually artificial waterways—"proof" of the existence of intelligent life on the planet. Later studies, and especially the space probes of the 1960's and 1970's, demonstrated that the canals were just optical illusions. Yet, even while spacecraft were eliminating the intelligent life theory, they were revealing a world of scientific wonders. These discoveries will stimulate future missions and research. Mars will continue to fascinate mankind and it will probably be the first planet that we visit in person, perhaps early in the 21st Century.

This publication takes a look at some of the more striking geographical features of Mars and compares them with well-known Earth features, at the same scale. This will help us to gain a better understanding of size relationships between the two planets. The source for each picture is included and copies can be ordered. For information write to:

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National Aeronautics and Space Administration
Washington, D.C. 20546

Maps of Mars are also available. For information write to:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092

MARS AND EARTH

Mars and the Earth are shown at the same scale. Mars is only about half the Earth's size. Its diameter is 6,796 kilometers (4,223 miles) while the Earth's diameter is 12,756 kilometers (7,927 miles).

In Figure 2, two Mercator map projections display the generalized topographic surfaces of Mars and the Earth at the same scale. It is readily apparent that Mars has much less total area than the Earth, but note that Mars has almost the same area as the Earth's *continents* combined.

The map in Figure 3 shows the locations of the major Martian landforms discussed in this publication. Also indicated are the Viking 1 and Viking 2 landing sites.

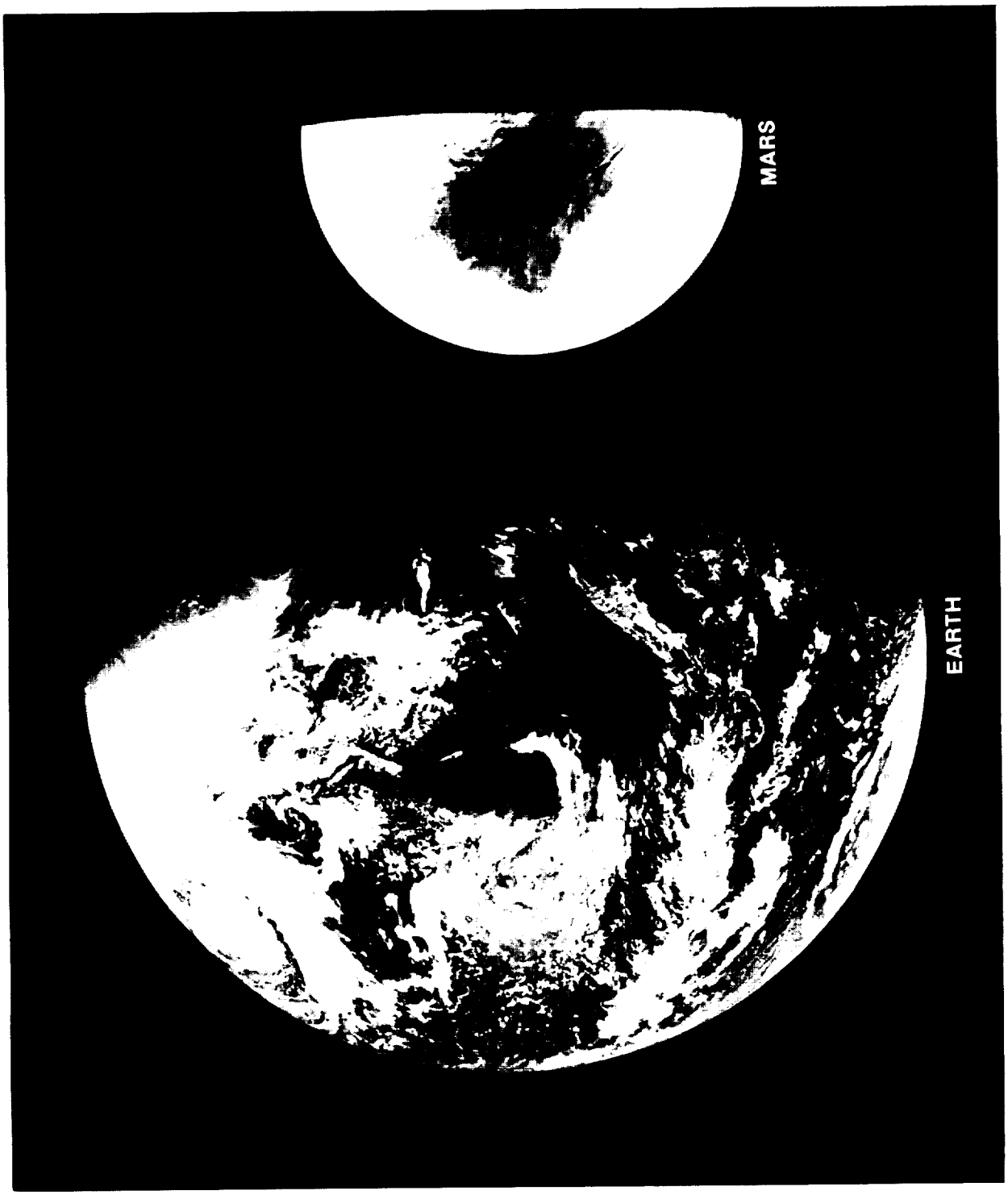

Figure 1: Mars and Earth compared.

(Source: NASA photo 83 H 230.)

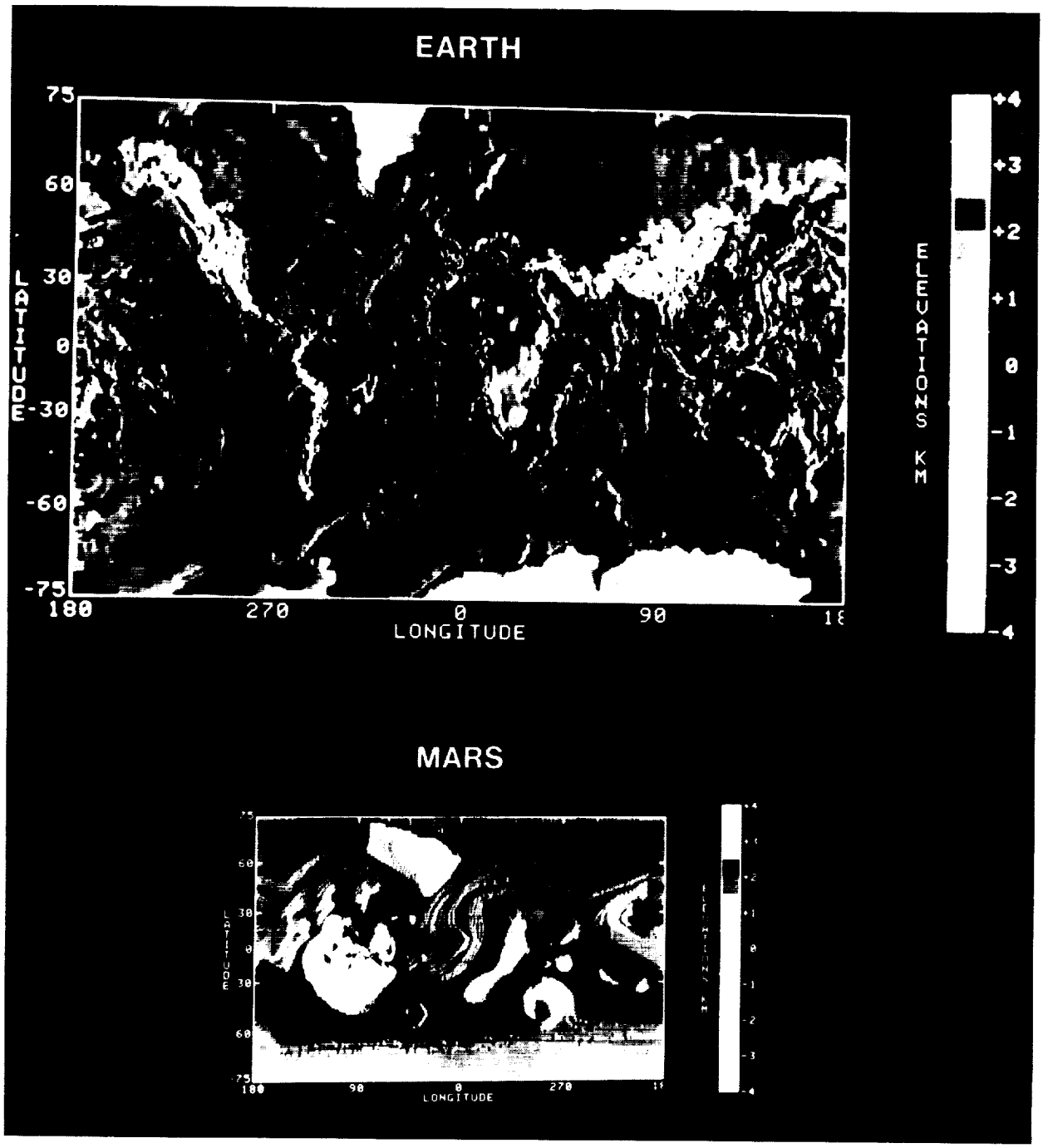

Figure 2: Mars and Earth Mercator Projections.

(Source: NASA photo 84 H 593.)

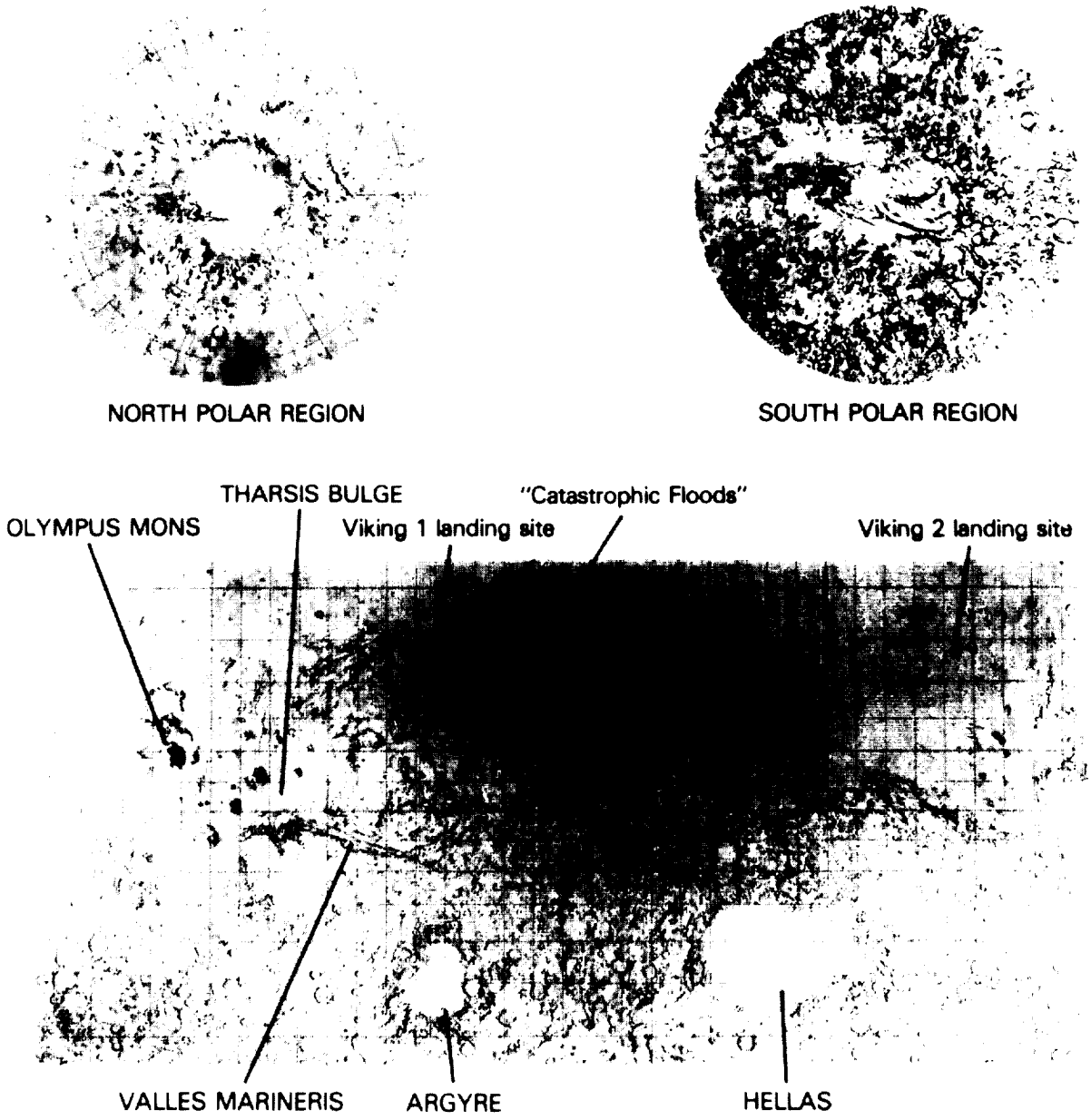

Figure 3: Selected Martian Landforms.

(Source: NASA photo 84 H 594.)

VALLES MARINERIS

Named after the Mariner 9 spacecraft that discovered it, Valles Marineris is a huge canyon system on Mars. It extends in an easterly direction for about 5,000 kilometers (3,000 miles), has a width of approximately 240 kilometers (150 miles), and depths up to 6.5 kilometers (4 miles). The origin of Valles Marineris is not known, but it is clearly a tectonic feature of vast proportions. Perhaps it represents an area of incipient plate tectonics which occurred during an earlier period in Martian history.

The accompanying photos demonstrate the huge extent of the Valles Marineris canyon system. Figures 4 and 5 compare it with the United States while Figure 6 shows that the Grand Canyon of Arizona is only the size of one of its tributary canyons.

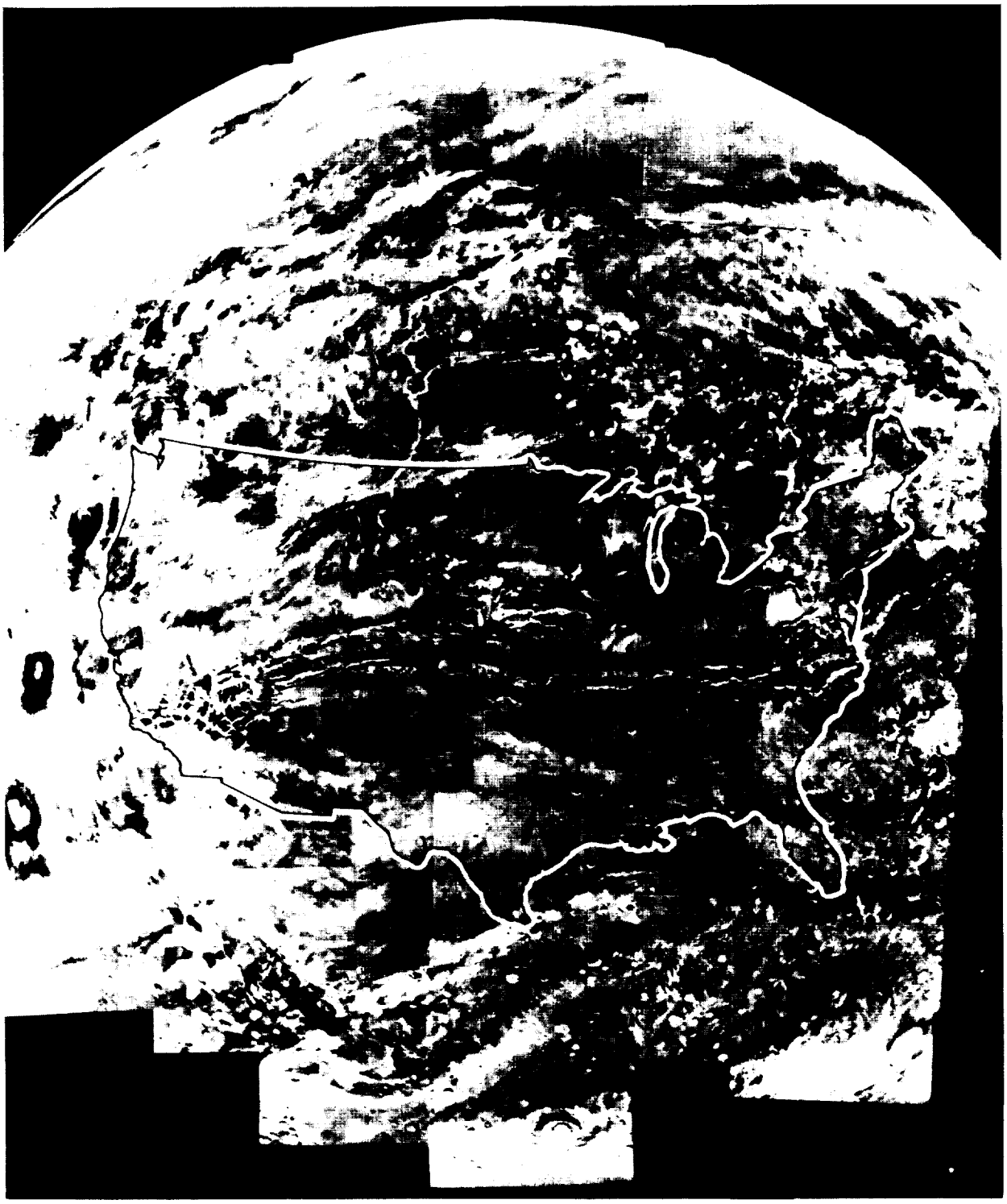

Figure 4: Valles Marineris compared to the United States.

(Source: NASA photo 83 H 244.)

Figure 5: Valles Marineris compared to the United States (airbrush map version).

(Source: NASA photo 84 H 595. This illustration is also available without the U.S. outline as NASA photo 84 H 596.)

Figure 6: Valles Marineris compared to the Grand Canyon.

(Source: NASA photo 75 H 495.)

THE THARSIS BULGE

The Tharsis bulge is an enormous elevated region of the Martian crust. It is roughly 5,000 kilometers (3,000 miles) across and has an elevation of around 7 kilometers (4 miles). Fractures radiate outward from it in all directions, including the Valles Marineris canyon system (see the previous section on "Valles Marineris"). Above the Tharsis, in a line, rise the huge volcanoes Ascraeus Mons, Pavonis Mons, and Arsia Mons (north-east to south-west). Olympus Mons lies on the northwest edge of the bulge (see the next section on "Olympus Mons"). All four of these great volcanoes penetrate over 26 kilometers (16 miles) into the Martian sky. The reason for the existence of the Tharsis bulge is not well understood, but it undoubtedly has had a role in the tectonic evolution of Mars.

The following illustrations demonstrate some of the size relationships associated with the Tharsis bulge. Figure 7 compares its area with the Central and Western United States. Figures 8 and 9 show one kilometer contour lines and cross sections across the bulge. It should be noted that although the tops of all four huge shield volcanoes reach the same elevation, the bases of only three of them lie on the crest of the Tharsis bulge (cross section A-A'). Olympus Mons is situated on the flank of the bulge. Therefore it rises from a lower elevation than the others, making it the highest vertical relief mountain of the group (cross section B-B'). Several well-known terrestrial volcanoes are also shown at the same scale, indicating the truly immense size of the Martian volcanoes. Figures 10 and 11 compare these volcanoes with the East and West Coasts of the United States.

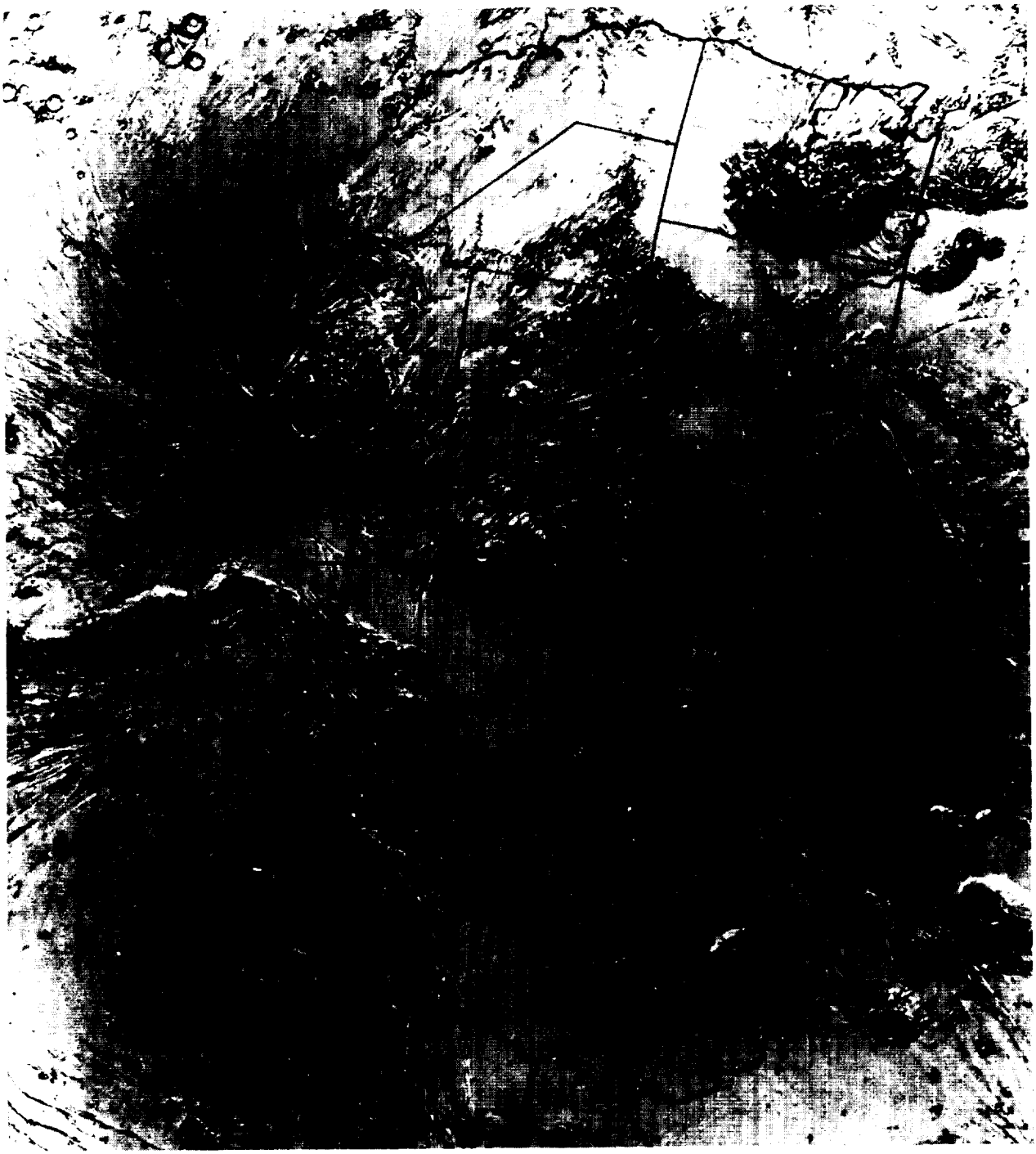

Figure 7: The Tharsis bulge compared to the United States.

(Source: NASA photo 84 H 597. This illustration is also available without the U.S. outline as NASA photo 84 H 427.)

Figure 8: Elevations of the Tharsis bulge.

(Source: USGS map I-961; Atlas of Mars 1:25,000,000 Topographic Series M 25M 3 RMC, 1976.)

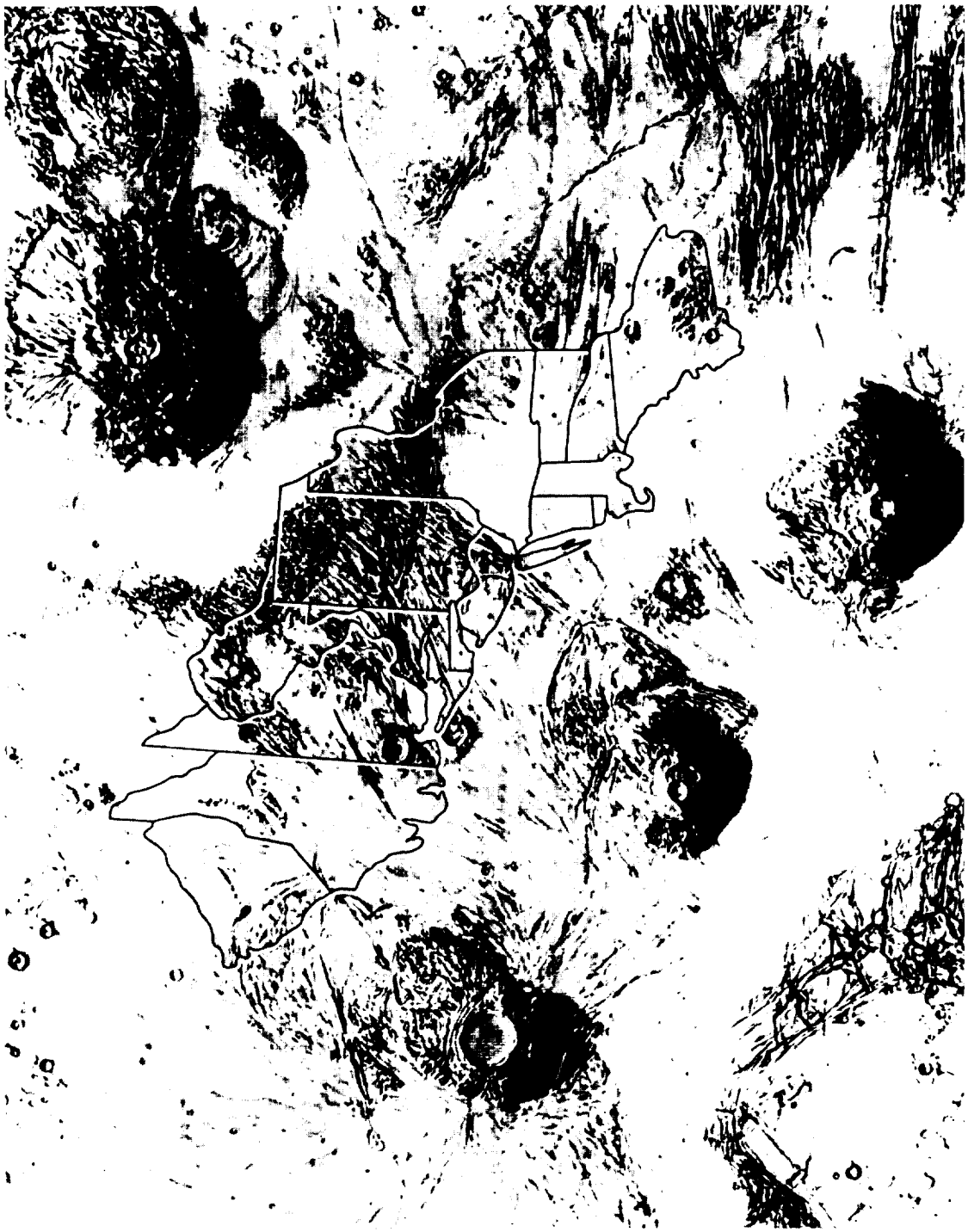

Figure 10: Volcanoes of the Tharsis bulge compared with the United States East Coast.

(Source: NASA photo 83 H 245.)

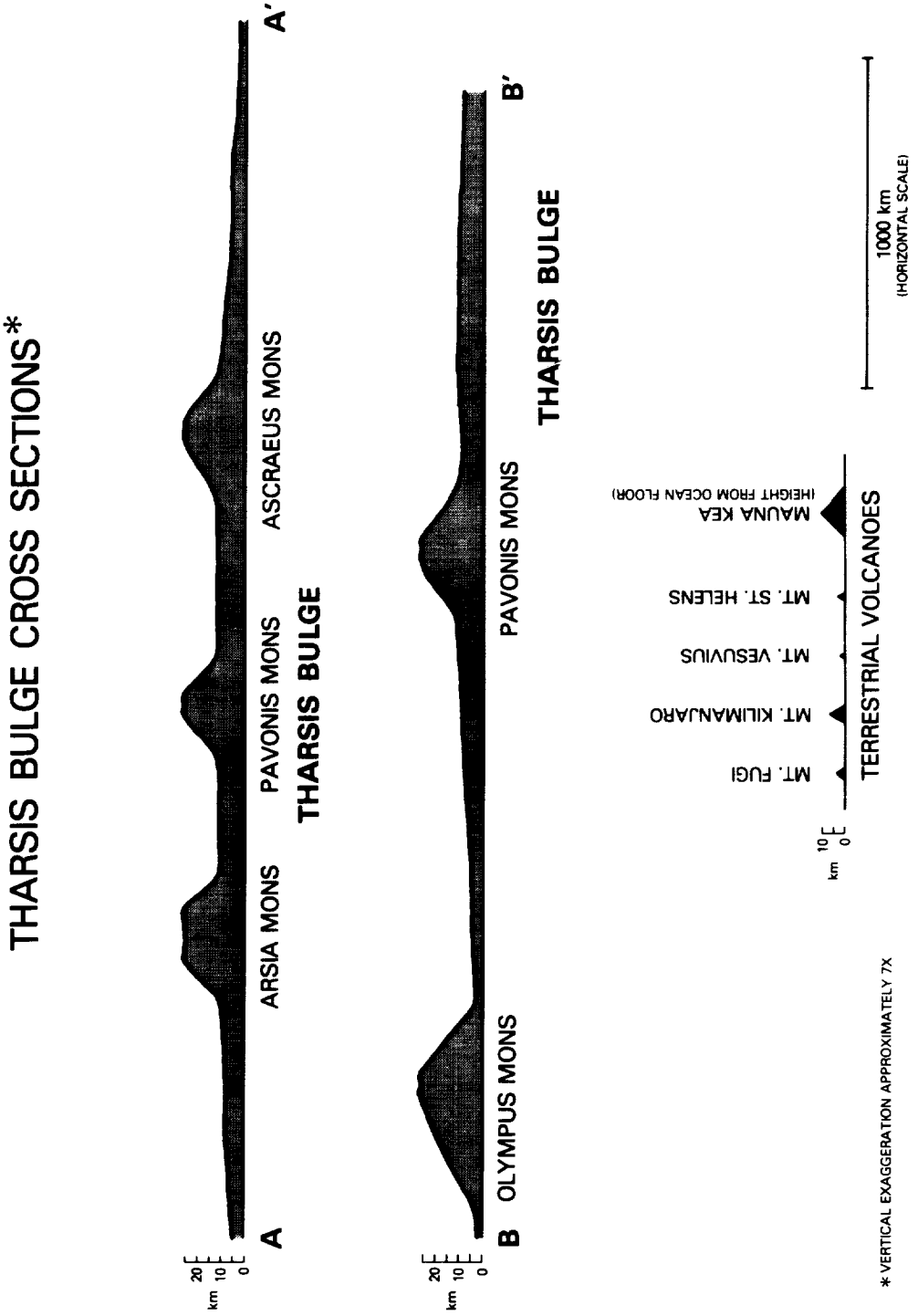

Figure 9: Cross sections across the Tharsis bulge.

(Source: NASA photo 84 H 598).

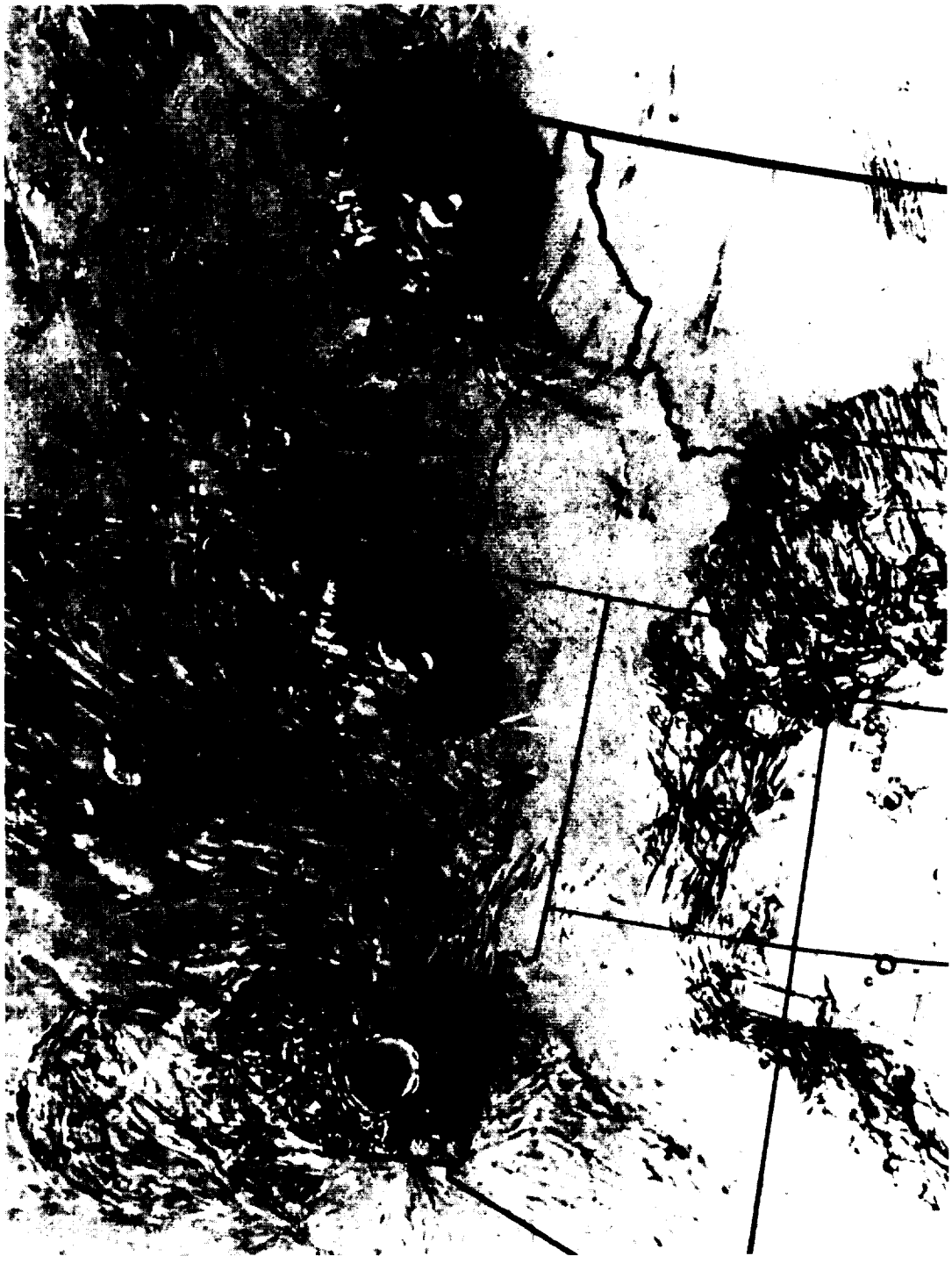

Figure 11: Volcanoes of the Tharsis bulge compared with the United States West Coast.

(Source: NASA Photo 84 H 599.)

OLYMPUS MONS

Olympus Mons is the largest known single volcano in the solar system. Located on Mars, this huge mountain is approximately 650 kilometers (400 miles) wide and rises over 26 kilometers (16 miles) into the thin Martian atmosphere. At its top is a complex caldera 80 kilometers (50 miles) across. Lava flows extend down its sides and over a 4 kilometer (2.5 mile) high scarp at its base. The origin of this scarp is unknown. Beyond the scarp, lava flows and other types of terrain associated with the volcano extend for hundreds of kilometers across the Martian plains.

It is thought that Olympus Mons has grown so large because it has remained stationary over its lava source. On the Earth plate movement does not allow this; terrestrial volcanoes, such as those of the Hawaiian Islands, can only achieve moderate size before they are shifted from their source regions and become extinct. Thus, Olympus Mons has in contrast been able to grow continuously for perhaps over a billion years.

Figure 12 gives a general panorama of Olympus Mons as seen by the Mariner 9 spacecraft and also a close up view of part of its caldera as photographed from one of the Viking orbiters. Figures 13 and 14 compare Olympus Mons with the state of Arizona and the Northeast United States, showing the incredible size of this vast feature. (See also the previous section on "The Tharsis bulge.")

Figure 12: Olympus Mons.

(Source: NASA Photo 83 H 249.)

Figure 13: Olympus Mons compared with Arizona (airbrush map version).

(Source: NASA photo 83 H 246.)

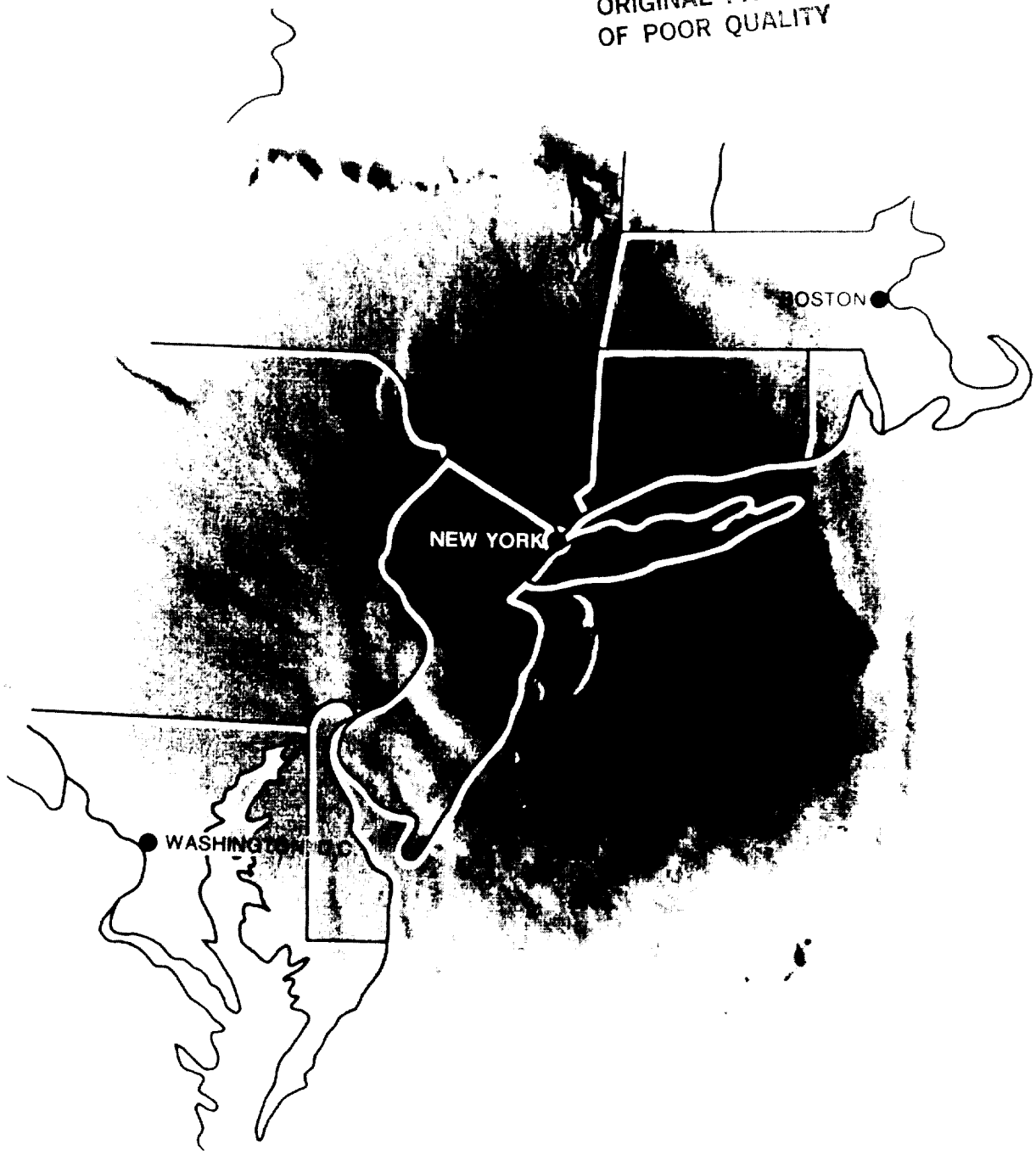

Figure 14: Olympus Mons compared with the Northeast United States.

(Source: NASA Photo 83 H 248.)

MAJOR MOUNTAINS COMPARED: EARTH AND MARS

The highest mountains on the Earth and Mars are compared in this diagram. Olympus Mons may have the highest vertical relief of any mountain in the solar system. Mount Everest is Earth's loftiest peak when measured from sea level. However, the volcano Mauna Kea on Hawaii is the Earth's highest, when measured from base to top. Much of Mauna Kea lies under the Pacific Ocean, with only 4 kilometers (2.5 miles) above sea level. (See also Figure 9.)

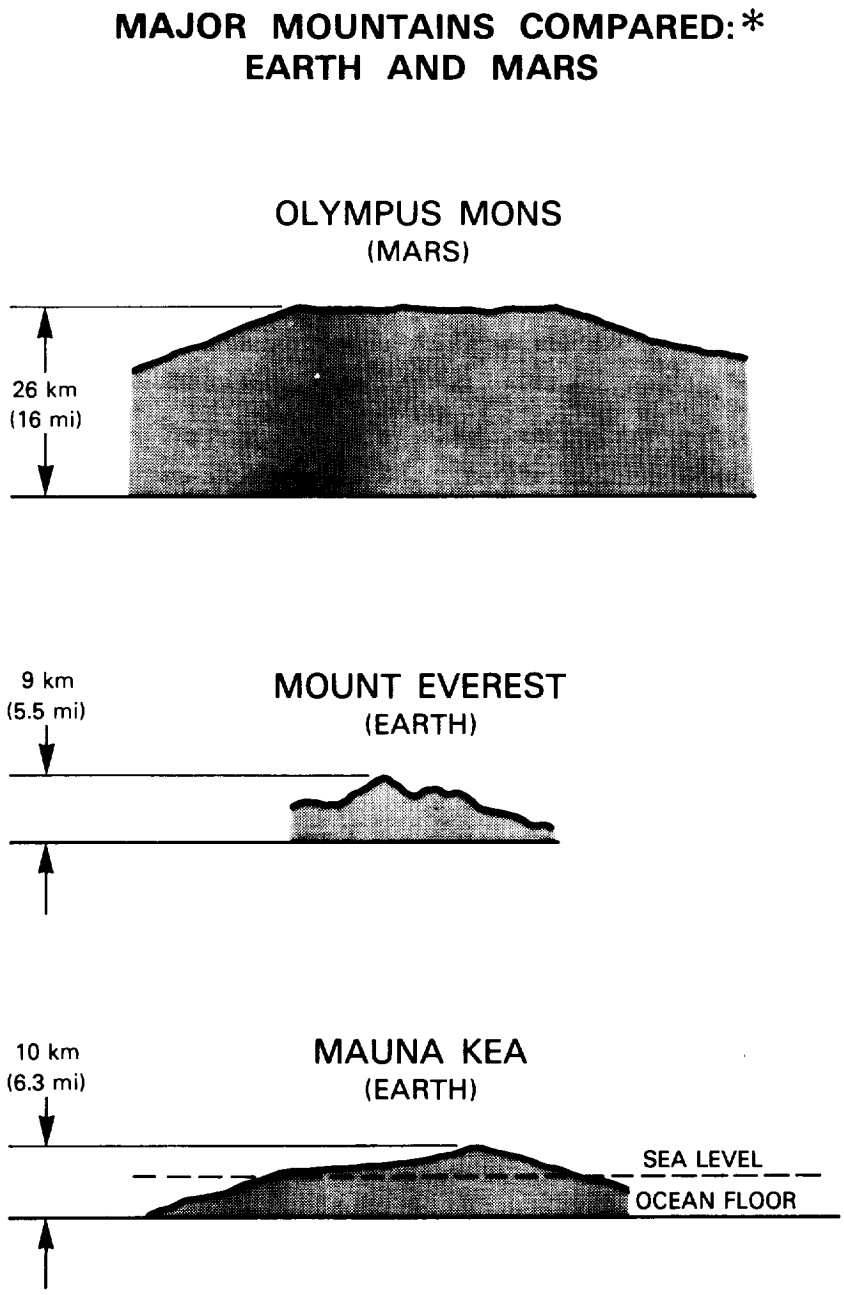

Figure 15: Major mountains compared: Earth and Mars.

(Source: NASA Photo 84 H 425.)

HELLAS AND ARGYRE

Hellas and Argyre are two immense basins found in the southern hemisphere of Mars (see Figure 3). They were apparently caused by the impacts of asteroids about 4 billion years ago. Hellas has a diameter of approximately 2,000 kilometers (1,200 miles) while Argyre has a diameter of 1,200 kilometers (750 miles). Figure 16 shows how these two basins compare in size with the United States. Hellas would cover most of the Western states and Argyre would extend over a large portion of the Eastern section of the country.

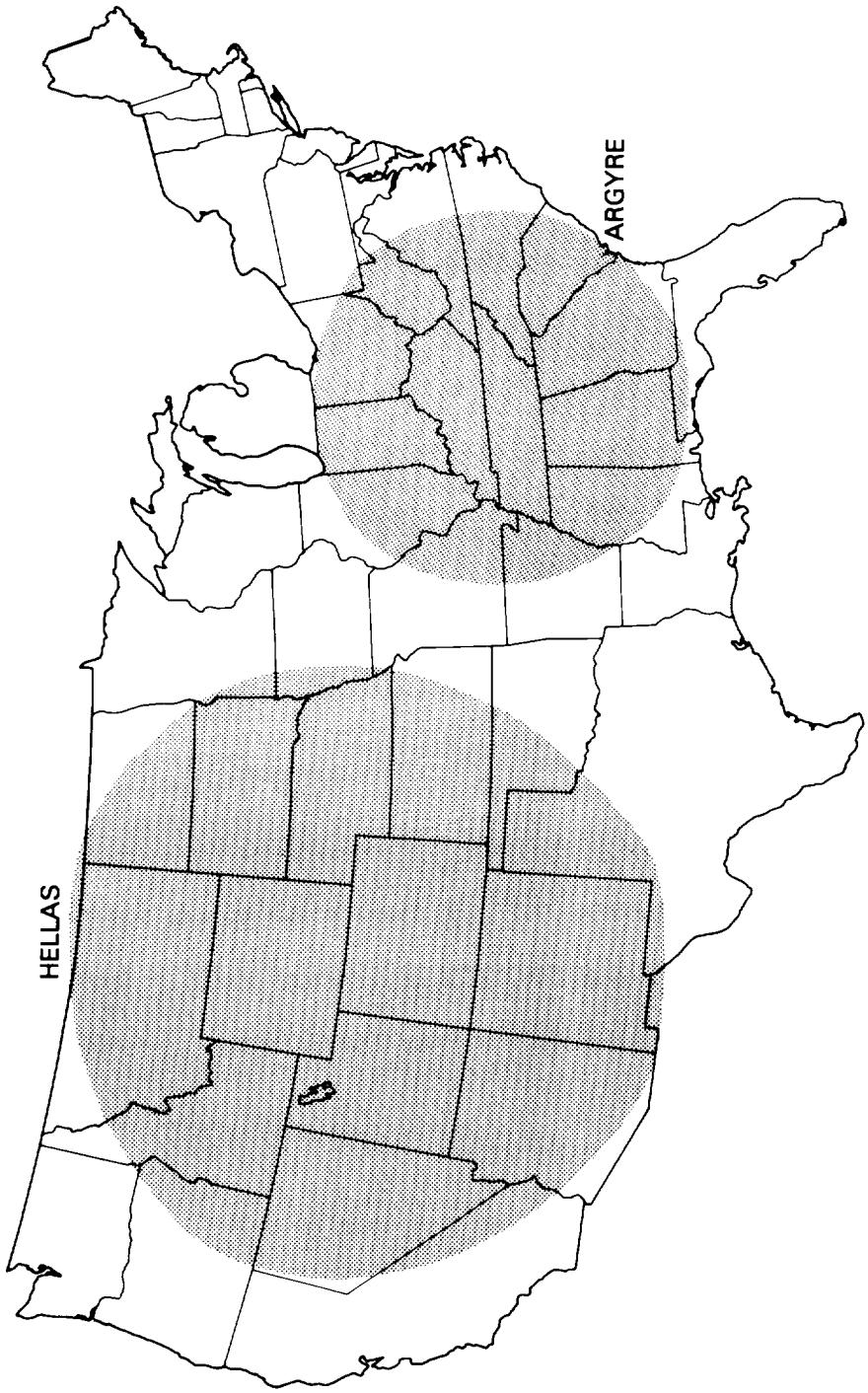

Figure 16: The areas of Hellas and Argyre compared with the United States.

(Source: NASA Photo 84 H 600.)

CATASTROPHIC FLOODS

One of the great discoveries of the Mariner 9 spacecraft was the existence of channels on Mars. There are several types, but the largest and most impressive are the outflow channels. These are features that generally start in jumbled terrain, emerge full size, and flow out onto the plains where they gradually disappear. The unusual thing about these channels is their vast size. They may achieve widths of over 200 kilometers (125 miles) and lengths in excess of 2,000 kilometers (1,200 miles). Although several theories have been put forward concerning their origin, the leading one proposes that these channels were caused by catastrophic floods of liquid water. How this could have happened is not clear, although it may have involved the sudden melting of permafrost and release of large volumes of underground water. Many of the outflow channels are geologically old and consequently indicate a greater amount of water available in the past. This could be a sign of long-term climatic changes on Mars.

Figure 17 is a mosaic of Viking spacecraft photographs showing an area of typical outflow channel terrain. The inset photo shows the Channeled Scablands of Washington's Columbia Plateau at the same scale. The Channeled Scablands are an extensive landform caused by flooding that occurred about 20,000 years ago. Since this landform represents one of the largest deluges known on Earth, its small size when compared to the catastrophic floods of Mars indicates how vast the Martian floods really were.

Figure 17: Catastrophic floods on Mars.

(Source: NASA Photo 84 H 430.)

THE POLAR REGIONS

Like the Earth, Mars has polar caps that wax and wane with the seasons. Figure 18 shows a global view of the north polar region as photographed by the Mariner 9 spacecraft. Because of the much lower temperatures on Mars and the composition of its atmosphere (primarily carbon dioxide), most of its polar "snow" is actually a thin coating of carbon dioxide frost. However, spacecraft measurements have determined that the small residual ice cap that remains during the summer season in the northern hemisphere is actually made up of water ice. The same is probably true of the southern hemisphere ice cap.

Figures 19 and 20 compare the polar regions of Mars and the Earth at the same scale. In each case the ice caps are shown at approximately their minimum extent.* This allows a direct comparison of water ice content. The residual north polar cap of Mars is considerably larger than its south polar cap, while the reverse is true on the Earth. Of course, the area of polar ice cover on the Earth is vastly greater than on Mars, reflecting the abundance of water available and the larger size of our planet. On the Earth ice depths of several kilometers may be found in some of the polar areas. On Mars the depth of the ice cover is unknown but it is undoubtedly quite thin by Earth standards. This again indicates the scarcity of water available on Mars, a desert world.

*The north and south polar regions of Mars are shown as they appeared on August 4, 1972 and February 28, 1972 respectively. The sea ice data for the north and south polar regions of the Earth was generalized from Nimbus-7 SMMR data for September 1-5, 1979 and February 1-5, 1979 respectively, and represent sea ice concentration of approximately 90% to 100% of ocean surface. The source of the continental ice cap information for the north polar region was the "Map of the Arctic Region" by the American Geographical Society, New York, 1975. All four maps are Polar Stereographic Projections.

Figure 18: The north polar region of Mars as seen by the Mariner 9 spacecraft.

(Source: NASA photo 72 H 1201.)

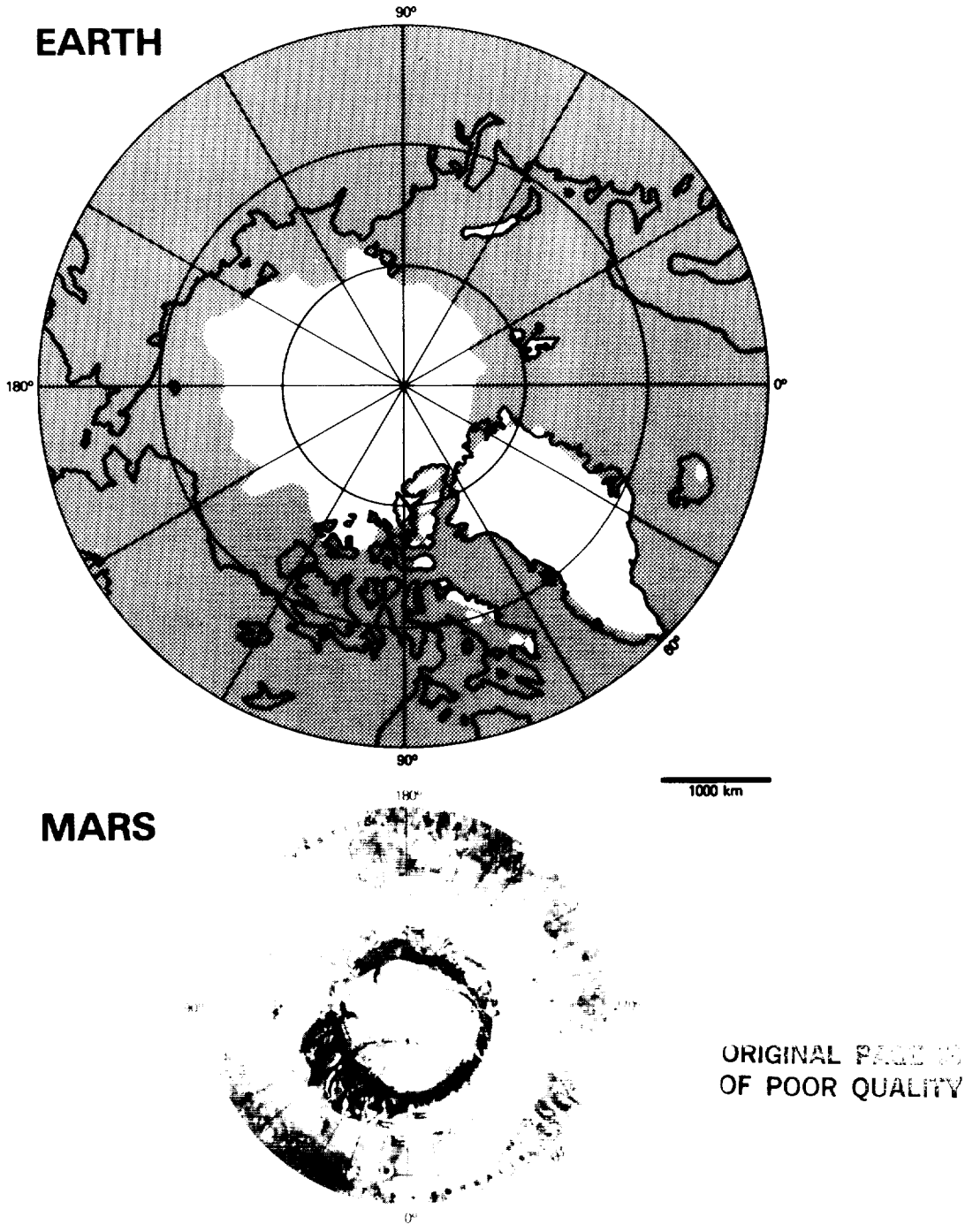

Figure 19: The north polar regions of Earth and Mars compared.

(Source: NASA photo 84 H 601.)

SOUTH POLAR REGIONS

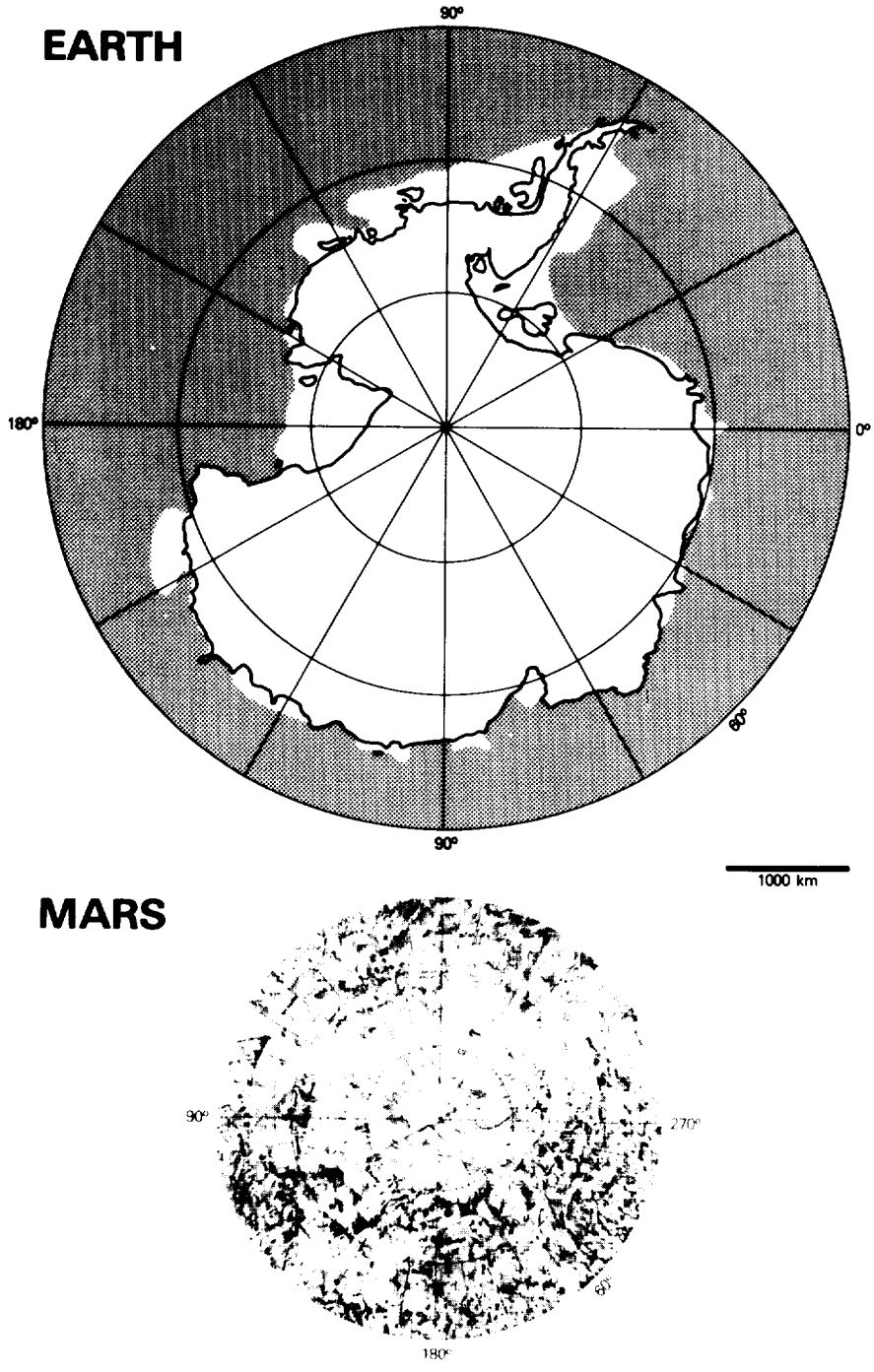

Figure 20: The south polar regions of Earth and Mars compared.

(Source: NASA photo 84 H 602.)

(Figures 19 and 20 are available together as NASA photo 84 H 603.)

PHOBOS AND DEIMOS

Phobos and Deimos, the two small moons of Mars, are compared in size with Manhattan Island in New York City. They are very irregular in shape but are approximately 22 kilometers (14 miles) and 12 kilometers (7 miles) in diameter respectively. One theory for their origin is that they were once asteroids that have been captured by the gravitational attraction of Mars.

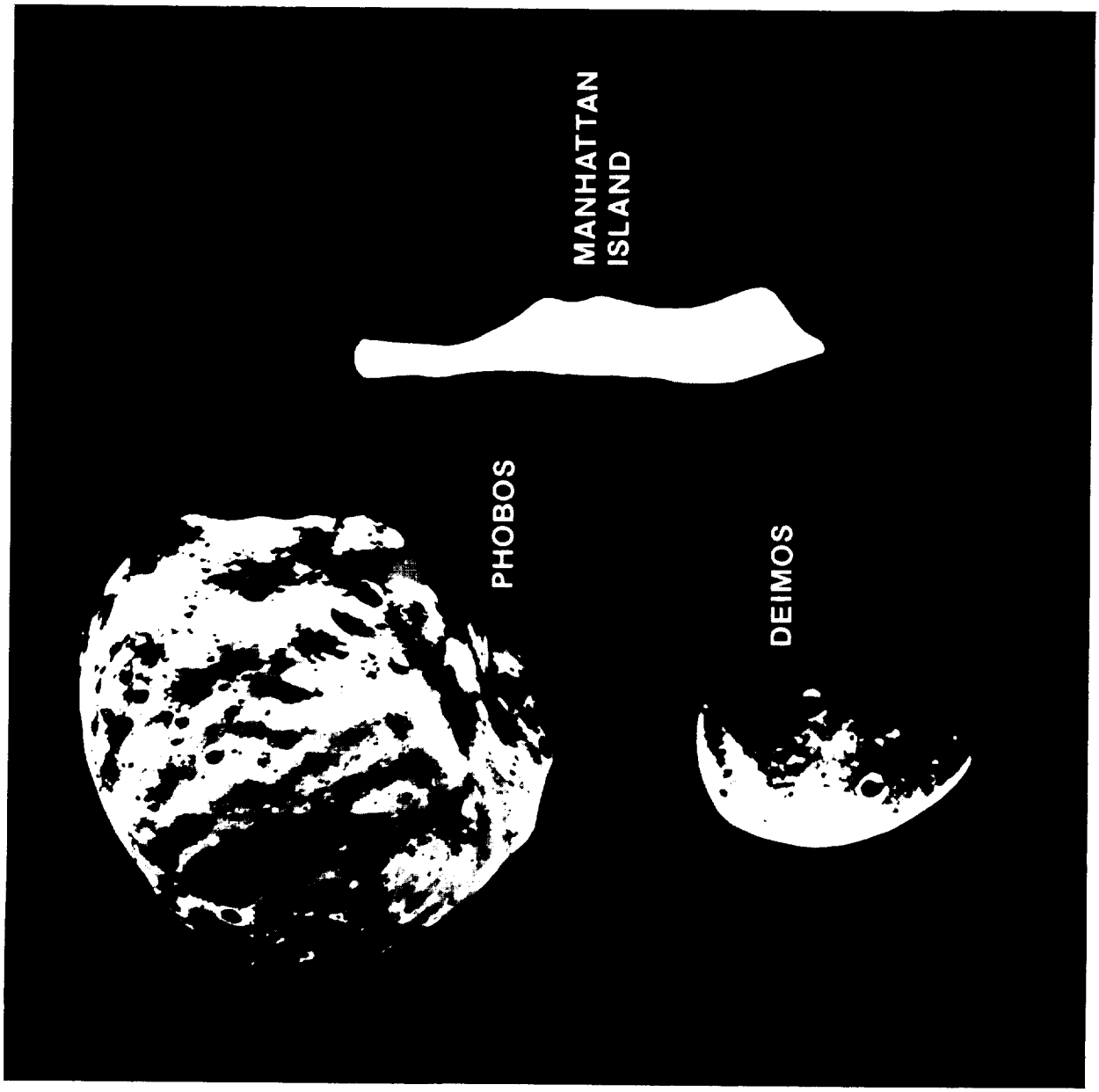

Figure 21: Phobos and Deimos compared with Manhattan Island.

(Source: NASA photo 83 H 226.)

THE SURFACE OF MARS

These photographs are panoramic views of the surface of Mars as seen from the Viking 1 and Viking 2 lander spacecraft. (See Figure 3 for the geographical locations of the landers.) The Viking 1 picture shows the presence of prominent sand dunes near the spacecraft while the terrain around Viking 2 has a more blocky appearance. Some deserts of Earth have landscapes that look very similar to the views in these photos.

(Source: NASA Photo 83 H 253.)

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