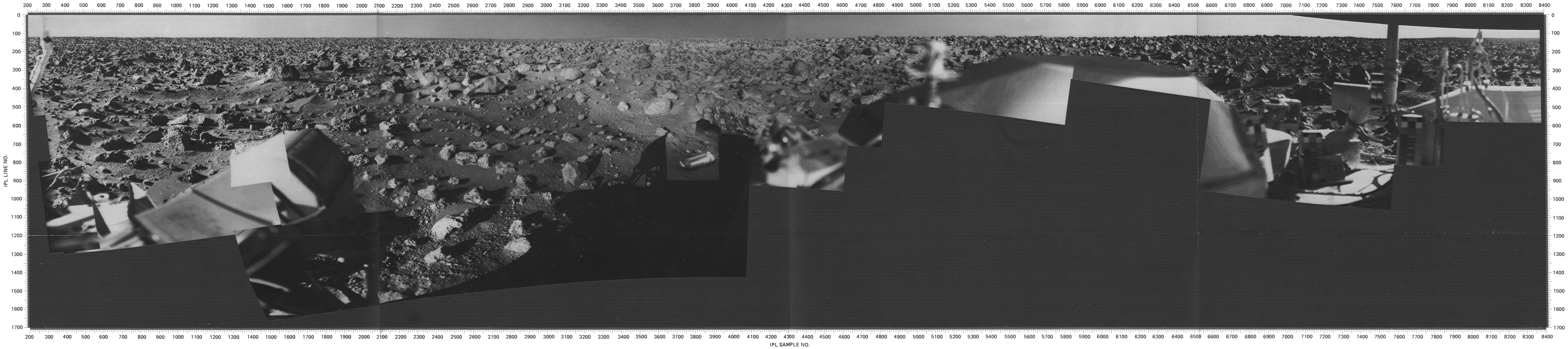
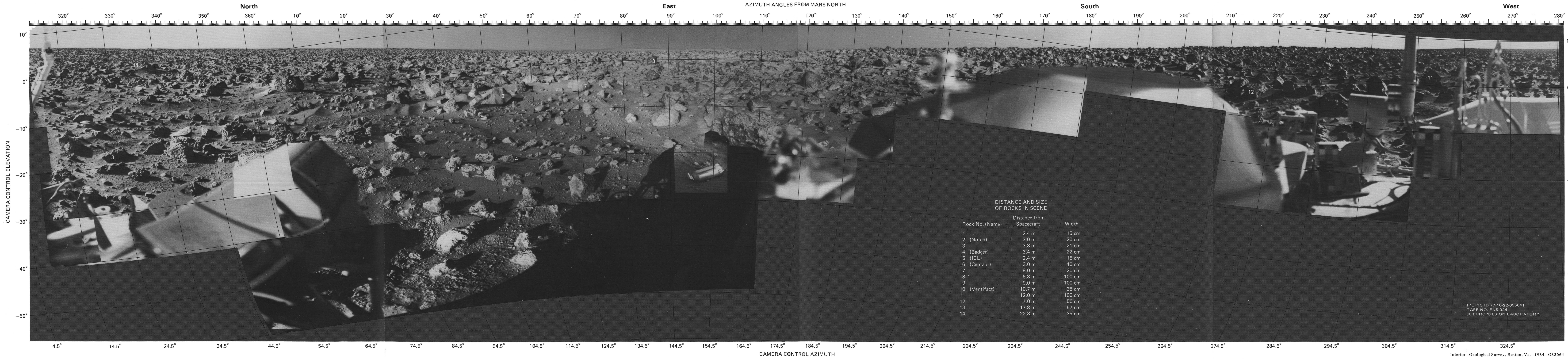
Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION





DISTANCE AND SIZE OF ROCKS IN SCENE

Rock No. (Name)	Distance from Spacecraft	Width
1.	2.4 m	15 cm
2. (Notch)	3.0 m	20 cm
3.	3.8 m	21 cm
4. (Badger)	3.4 m	22 cm
5. (ICL)	2.4 m	18 cm
6. (Centaur)	3.0 m	40 cm
7.	8.0 m	20 cm
8.	6.8 m	100 cm
9.	9.0 m	100 cm
10. (Ventifact)	10.7 m	38 cm
11.	12.0 m	100 cm
12.	7.0 m	50 cm
13.	17.8 m	57 cm
14.	22.3 m	35 cm

Interior–Geological Survey, Reston, Va.–1984–G83064

A high-resolution lander mosaic (noon) was transformed to produce the donut-like presentation of the horizon. Lander tilt was removed from the projection. A second transformation was used to connect elevation angles relative to the local vertical to a radius function and azimuth relative to north to a circular function. The result is a polar stereographic projection with the property that camera distortions resulting from different sampling at different elevations are removed. IPL picture I.D. 78/01/14/054523.

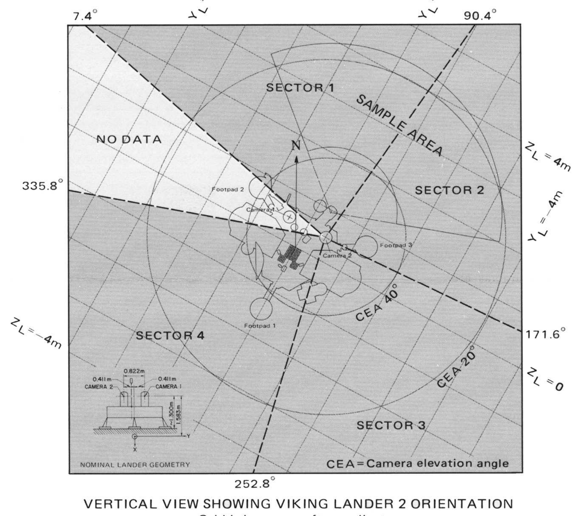
DESCRIPTION OF SCENE

Viking Lander 2 pictures show the flat level plain of Utopia Planitia strewn with rocks in the centimeter to meter size. Most rocks are subangular, equidimensional, and spongelike. The pits and holes in the rocks, which range from a few millimeters to a few centimeters in diameter, may be vesicles formed by solidification from a frothy gas-charged lava. Patches of pebbly fragments (line 1100, sample 3000) and small drifts of fine-grained material (line 340, sample 3000) are distributed among the large blocks. The blocks appear to be fairly uniformly distributed out to the horizon. Most of the blocks appear to lie on the surface of fine-grained material, probably because of scouring or winnowing of the fine-grained material by the martian winds. Much of the fine-grained material in the interblock areas is bound in a crust which breaks into platy fragments when disturbed (line 1500, sample 2600). About 8 m in front of the lander trending from left to right is a small trough about 1 m wide and 10 cm deep (line 330, sample 300; line 630, sample 2800). Several small drifts of fine-grained material bury parts of the trough (line 480, sample 1700) and occupy its floor. The trough is part of a roughly polygonal network that probably developed from contraction either by cooling of a lava or from thermal expansion or contraction of frozen ground.

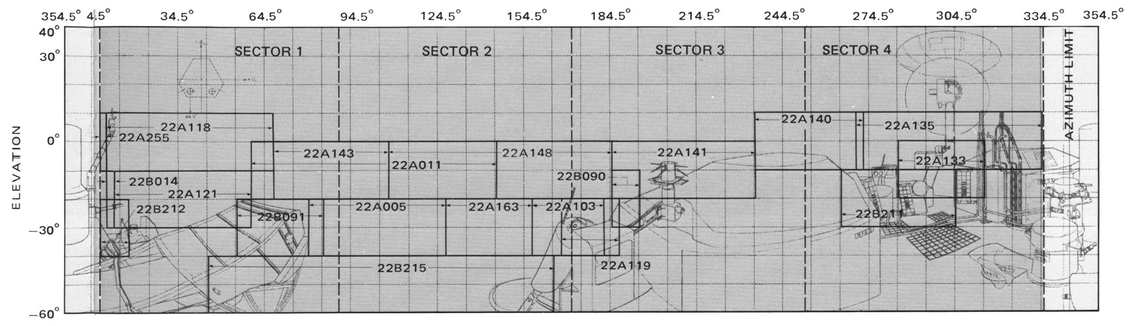
East of the lander, barely visible on the horizon are several flat-topped bluffs or plateaus (line 150, sample 3300) that may be ejecta flow lobes from a large impact crater, 100 km diameter that lies about 170 km east of the landing site.

The cylindrical object (line 800, sample 3800) lying on the surface in the foreground to the right of the spacecraft is a hollow metal canister that covered the surface sampler until after landing on Mars. The canister was ejected from the sampler arm upon command from Earth; it struck a rock near footpad 3, bounced, and came to rest in its present position.

Parts of the spacecraft that are visible in the panorama are: meteorological instruments on the end of a boom (line 20, sample 290); the box or housing in which the meteorological instruments were stored during transit to Mars (line 1100, sample 700); the surface sampler (line 800, sample 1600), the true form of the instrument is not shown in this mosaic of pictures that were taken at different times when the instrument was in different positions; mounting structure for leg 3 (line 800, sample 4400); low gain S-band antenna (line 200, sample 5100); cover of a Radioisotope Thermoelectric Generator (RTG) (line 300, sample 5900); three-color test charts used for calibration of the cameras (line 650, sample 6800; line 750, sample 7150; line 700, sample 7680); seismometer (line 700, sample 6980); mounting structure for leg 1 (line 500, sample 7000); parabolic mirror for viewing magnets on the surface sampler (line 680, sample 7280); mounting structure and mast of the high gain S-band antenna (line 450, sample 7400); and RTG cover (line 450, sample 8200).



VERTICAL VIEW SHOWING VIKING LANDER 2 ORIENTATION
Grid is in spacecraft coordinates



OUTLINE OF CAMERA 2 VIEW SHOWING CAMERA EVENTS USED IN MOSAIC

THE VIKING MISSION

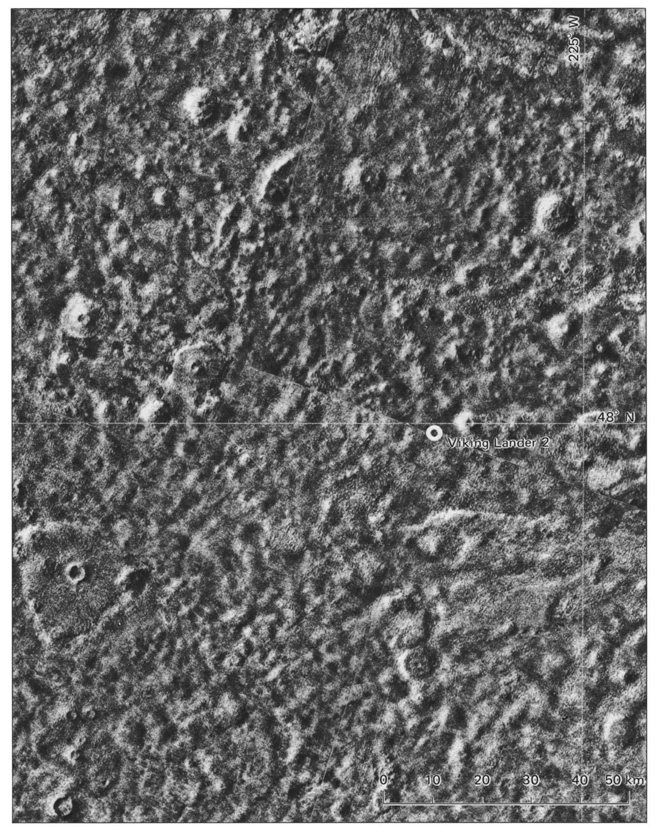
Two Viking spacecraft, each consisting of an orbiter and lander, were launched from Kennedy Space Center on August 20 and September 9, 1975. The Viking 1 spacecraft arrived at Mars on June 19, 1976, and was placed in a highly elliptic orbit around the planet at a periapsis altitude of nearly 1500 km. The orbiter cameras were used in conjunction with other instrumental methods to find a suitable landing site for the lander. After about 30 days in orbit, the lander was separated from the orbiter, and on July 20, 1976, Viking Lander 1 touched down on the surface of Mars at lat 22.483° N.* and long 47.968° W. (Morris and Jones, 1980) on the west edge of a large basin called Chryse Planitia. It landed in a stable position at a 3° tilt downward in the direction 284.9° clockwise from north.

The side of the lander on which the two cameras are mounted faces southeast. When the cameras are pointed in a direction normal to the front of the lander, the viewing direction is 141.6° clockwise from north along the horizon. The first picture from the surface of Mars, of an area near the lander's footpad 3, was taken immediately after landing by camera 2. During the ensuing 43 days, the cameras responded to all commands and successfully carried out their assigned mission. On September 2, the activities of Lander 1 were reduced to accommodate the planned receipt of data from Viking Lander 2.

On September 3, 1976, Viking Lander 2 successfully landed on Utopia Planitia of Mars (47.966° N., 225.736° W.), more than 6500 km northeast of Lander 1 (Mayo and others, 1977; Davies and others, 1978). Lander 2 faces approximately north and tilts 8.2° downward in the direction of 277.4° clockwise from north. The viewing direction of its cameras when pointed in a direction normal to the front of the lander is 29.0° clockwise from north along the horizon. The cameras on Viking Lander 2 operated successfully for 61 days until the primary mission of both landers was completed on November 15, 1976, at solar conjunction.

During the primary mission, 454 pictures of the martian surface were processed from Viking Lander 1 data and 582 pictures from Viking Lander 2 data. The extended mission of Viking began December 15, after solar conjunction, and ended in June 1978. During this period, an additional 1636 pictures were obtained from Lander 1 data and 1311 pictures from Lander 2 data. A comprehensive description of the Viking primary mission and the results of eight scientific experiments on board the landers were published in the Journal of Geophysical Research (v. 82, no. 28, Sept. 30, 1977; see References).

*Latitudes are areographic (see de Vaucouleurs and others, 1973).



Viking Orbiter pictures 9B13, 9B14, 9B15, 9B16 showing the location of Viking Lander 2.

VIKING LANDER MOSAICS

The Viking Lander cameras acquired many high-resolution pictures of the Chryse Planitia and Utopia Planitia landing sites. Each picture is the product of computer processing on Earth of digital-image data transmitted from Mars as a result of "camera events" carried out by one of the lander camera systems. Further computer processing of data from a selected number of these events yielded a total of 10 mosaics. Two pairs of mosaics from Lander 1 data (one mosaic from each camera) consisted of one pair made from data taken in the morning (0700-0800 hours) and one pair made with data acquired in midafternoon (1400-1530 hours). Similarly, three pairs of mosaics for the Lander 2 site consisted of one pair between 0700 and 0800 hours, one pair at noon, and one pair between 1700 and 1800 hours.

Procedures used for processing the Viking Lander camera data were described by Levinthal and others (1977). The individual camera events used in each mosaic are identified in the outline of the accompanying camera view. Detailed descriptions and reproductions of these camera events were given by Tucker (1978). Copies of the Viking Lander pictures can be obtained from the National Space Science Data Center, Goddard Space Flight Center, Greenbelt, MD., 20771.

The Lander camera system (Huck and others, 1975a) has selectable focus settings for a depth of field from 1.2 m to infinity in the high-resolution (0.04° instantaneous field of view) mode. The survey (low-resolution) mode has an instantaneous field of view of 0.12°; this mode was used in the mosaics only where no high-resolution data were acquired.

Each complete mosaic extends 342.5° in azimuth, from approximately 5° above the horizon to 60° below. A complete mosaic incorporates approximately 15 million picture elements (pixels). In order to manage the processing of such large data bases, each mosaic was compiled from four individual azimuthal sectors.

Most of the data used in the mosaics were selected from the primary mission. In some cases, extended-mission data were included where primary-mission coverage was absent or where the surface was obscured by the sampler arm. Further selection was made on the basis of optimum focus.

The image data were photometrically corrected (Huck and others, 1975b; Patterson and others, 1977; Wolfe and others, 1977) for differences caused by variations in exposure and for solar-lighting differences caused by minor time-of-day variations in the pictures of the set. The geometry was then transformed to a local Mars horizon and corrected for geometric camera errors (Patterson and others, 1977; Wolfe, 1981). The corrected pixels composing a sector were then combined by the computer into a single image, and an optimum contrast correction was applied.

The mosaics are composites of the best pixels of all the Lander pictures used for each sector. In the computer mosaicking process, the image data derived from the camera events for each sector were assigned priorities on the basis of quality or detail. These data were examined by the computer in sequence according to the priorities, and the best pixels of each data set were used for the mosaic.

The computer formatting of the Viking Lander mosaics was done at the Image Processing Laboratories of the Jet Propulsion Laboratory of the California Institute of Technology, Pasadena, Calif., under the general supervision of Elliott C. Levinthal of the Department of Genetics, Stanford University, who represented the Viking Lander Imaging Team. A detailed description of the multiple steps involved in the construction of the Viking Lander mosaics and an acknowledgment of the many people who assisted in the project were given by Levinthal (1980).

GEOMETRY OF THE MOSAICS

The cameras on the Viking Lander acquire data by sampling in equal increments of elevation and azimuth angle. In the accompanying mosaic, 2.9 mm subtends a 1° horizontal or vertical angle, regardless of the place of measurement within the panorama. If the martian surface were flat, one pixel (0.04°) on the surface would be 1 mm wide at -60° camera elevation and 2 m wide at the horizon 3 km away. Characteristically for this type of imaging system, most straight lines in the scene appear curved in the reconstruction. This representation of the picture data differs from that of a conventional camera having "point perspective" picture geometry, in which rays are projected from object space, through the perspective point in the camera lens, to an image plane in the camera.

The geometry of the lander pictures is complicated by additional factors. Because both landers are tilted with respect to the horizon, on the uncorrected pictures the horizon resembles a sine curve. Computer rectification of the pictures results in a straight horizon along which vertical angles can be measured with respect to the local gravity vector, and horizontal angles can be measured from martian north. These angles are not related in any simple way to the azimuth and elevation angles given in "camera coordinates" for the unrectified pictures.

There are other geometric distortions due to the camera: optic path distortion that affects a light ray after it passes the camera windows; and camera-system distortions, or "bolt-down" errors, that are caused by the way the cameras are mounted on the lander. The geometric transformation used in creating the mosaics took into account the optic path distortion but not the "bolt-down" errors. However, along the horizon, the error in azimuth angle is equal to the rotational "bolt-down" error for each camera to an accuracy of less than 1 pixel. The scale "azimuth angles from Mars north" has been adjusted to take into account this correction.

The residual azimuth angle errors are less than 1 pixel along the horizon and become larger with steeper elevation angles and large lander tilts. For the worst case, Lander 2, camera 1, this error is a maximum of 5.7 ± 1 pixels at -60° elevation. The somewhat sinusoidal azimuth-dependent residual elevation error is a maximum of 3 ± 1 pixels for Lander 2, camera 1, and approximately 1 pixel for the other cameras.

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VIKING LANDER 2 PHOTOMOSAIC
EVENING SCENE - CAMERA 2
1984

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