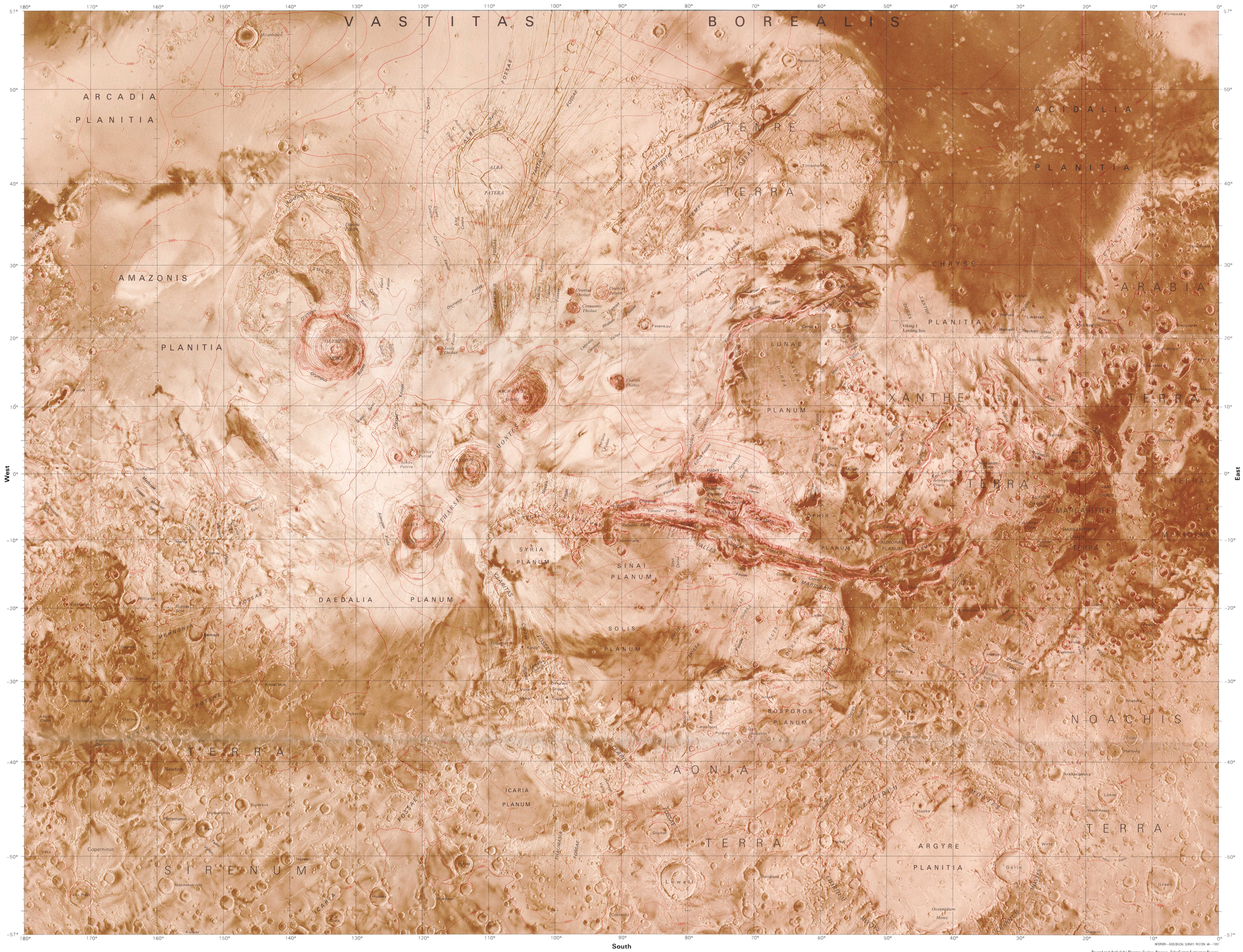
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ATLAS OF MARS
1:15,000,000 TOPOGRAPHIC SERIES
WESTERN REGION
M 15M 0/90 2AT, 1991
I–2160 SHEET 2 OF 3



NOTES ON BASE

This map is one of a three-sheet set that shows combined surface markings, shaded relief, and topographic contours of Mars. Shaded relief was taken from published maps (U.S. Geological Survey, 1985b). Surface markings (albedo) in the western and eastern regions are also those of existing maps (U.S. Geological Survey, 1985a); surface markings have been added in the polar regions and in areas not covered by the original set of Viking images used to compile the existing maps. Contours were taken from topographic maps of the U.S Geological Survey (1989).

PROJECTIONS

The figure of Mars used for computing the map projections is an oblate spheroid (flattening of 1/192) with an equatorial radius of 3,393.4 km and a polar radius of 3,375.7 km. This figure is less complex than the topographic figure (described below) on which the contour lines are based. The Mercator projection is used between lat ±57°, and the Polar Stereographic projection is used for the polar regions north and south of the 55° parallels. The projections have a common scale of 1:8,418,000 at lat ±56°. Longitude increases to the west in accordance with astronomical convention for Mars. Latitudes are areographic.

CONTROL

Horizontal and vertical controls were established by analytical photogrammetric areotriangulation (Wu and Schafer, 1984), by using the General Integral Analytical Triangulation (GIANT) program of the U.S. Geological Survey. Primary controls used in the control network include the Viking Orbiter Secondary Experiment Data Record, radio-occultation measurements from both Mariner 9 and Viking Missions (Lorell and others, 1972; Kliore and others, 1973; Lindal and others, 1979), Earth-based radar observations (Pettengill and others, 1971; Downs and others, 1975), and the Mars primary control network of the Rand Corporation (Davies and others, 1978).

ALBEDO

Original maps of the surface albedo were compiled from a selected set of Viking Orbiter 1 images acquired through red or clear filters when the solar planetocentric longitude (Ls) with respect to Mars was 65° to 89° and when the solar zenith angle was small. Complete coverage of the western and eastern regions could not be obtained during this period. Therefore, Viking Orbiter images acquired at different times, Mariner 9 images (Batson and Inge, 1976), maps made with the Viking Infrared Thermal Mapper (Pleskot and Miner, 1981), and a map compiled from Earth-based pictures (Inge and others, 1976) were used as necessary to complete the mapping. These sources are not necessarily consistent with the seasonal constraints of the first dataset. Details of the albedo markings were drawn on photographic copies of the original shaded relief maps. The overall albedo balance was maintained by reference to the low-resolution, solar albedo map and to the Earth-based source.

Analysis and portrayal of albedo markings were made by Susan L. Davis and Jay L. Inge.

PLANIMETRY

The mapping bases used for these three sheets (U.S. Geological Survey, 1985b) were assembled from 1:5,000,000-scale shaded relief maps (Batson and others, 1979), reduced and digitally transformed to the projections described above. These bases were used to position details taken from Viking Orbiter pictures during shaded relief protrayal. Shaded relief is shown as if illuminated from the west. Airbrush protrayals of both the relief and albedo were done according to interpretive techniques described by Inge and Bridges (1976).

Shaded relief analysis and portrayal were made by Barbara J. Hall.

CONTOURS

Because Mars has no surface water and hence no sea level, the datum (the 0-km contour line) for elevations is defined by a gravity field described by spherical harmonics of fourth order and fourth degree (Jordan and Lorell, 1973), combined with a 6.1-millibar atmospheric pressure surface derived from radio-occultation data (Kliore and others, 1973; Christensen, 1975). This datum can be approximated by a triaxial ellipsoid with semi-major axes of A=3,394.6 km and B=3,393.3 km and a semi-minor axis of C=3,376.3 km. Semi-major axis A intersects the Martian surface at long 105° (Wu, 1978, 1981).

Contour lines between the ±30° parallels were transferred from the 1:2,000,000-scale topographic maps originally compiled from Viking Orbiter images on analytical stereoplotters (Wu and others, 1982). Contour lines north and south of lat ±30° were compiled from measurements made by both Viking and Mariner 9 experiments, which employed the ultraviolet spectrometer (Hord and others, 1974) and the infrared interferometer spectrometer (Conrath and others, 1973), and from elevation data of both the Mars primary control network (Davies and others, 1978) and the Mars planetwide control network (Wu and Schafer, 1984).

COLOR

No attempt was made to duplicate the color of the Martian surface although the color used may approximate it.

NOMENCLATURE

Names on this sheet are approved by the International Astronomical Union (IAU, 1974, 1977, 1980, 1983, 1986, and in press), except for provisional names, which are indicated by an asterisk. The positions of named features are taken from published maps of Mars.

M 15M 0/90 2 AT: Abbreviation for Mars; 1:15,000,000 series; center of map, lat 0°, long 90°; 2nd edition; shaded relief with albedo markings (A), topographic contours and nomenclature (T).

REFERENCES

Batson, R.M., Bridges, P.M., and Inge, J.L., 1979, Atlas of Mars, The 1:5,000,000 map series: National Aeronautics and Space Administration, SP-438, 146 p.

Batson, R.M., and Inge, J.L., 1976, Albedo boundaries on Mars in 1972: Results from Mariner 9: Icarus, v. 27, no. 3, p. 531–536.

Christensen, E.J., 1975, Martian topography derived from occultation, radar, spectral, and optical measurements: Journal of Geophysical Research, v. 80, no. 20, p. 2909–2913.

Conrath, B.J., Curran, R.K., Hanel, R.A., Kunde, V.G., Maguire, W.W., Pearl, J.C., Pirraglia, J., and Welker, J., 1973, Atmospheric and surface properties of Mars obtained by infrared spectroscopy on Mariner 9: Journal of Geophysical Research, v. 78, no. 20, p. 4267–4278.

Davies, M.E., Katayama, F.Y., and Roth, J.A., 1978, Control net of Mars: February 1978: The Rand Corporation, R–2309–NASA, 91 p.

Downs, G.S., Reichley, P.E., and Green, R.R., 1975, Radar measurements of Martian topography and surface properties: Icarus, v. 26, no. 3, p. 273–312.

Hord, C.W., Simmons, K.E., and McLaughlin, L.K., 1974, Mariner 9 ultraviolet spectrometer experiment: Pressure altitude measurements on Mars: Icarus, v. 21, no. 3, p. 292–302.

Inge, J.L., and Bridges, P.M., 1976, Applied photointerpretation for airbrush cartography: Photogrammetric Engineering and Remote Sensing, v. 42, no. 6, p. 749–760.

Inge, J.L., Martin, L.J., and Capen, C.F., 1976, Mars: 1975–1976: Lowell Observatory Map Series, scale 1:25,000,000.

International Astronomical Union, 1974, Commission 16: Physical study of planets and satellites *and* Lunar and martian nomenclature, *in* 15th General Assembly, Sydney, 1973, Proceedings: International Astronomical Union Transactions, v. 15B, p. 105–108, 217–221.

———1977, Working Group for Planetary System Nomenclature, *in* 16th General Assembly, Grenoble, 1976, Proceedings: International Astronomical Union Transactions, v. 16B, p. 321–325, 331–336, 355–362.

———1980, Working Group for Planetary System Nomenclature, *in* 17th General Assembly, Montreal, 1979, Proceedings: International Astronomical Union Transactions, v. 17B, p. 293–297.

———1983, Working Group for Planetary System Nomenclature, *in* 18th General Assembly, Patras, 1982, Proceedings: International Astronomical Union Transactions, v. 18B, p. 334–336.

———1986, Working Group for Planetary System Nomenclature, *in* 19th General Assembly, New Delhi, 1985, Proceedings: International Astronomical Union Transactions, v. 19B, p. 347–350.

———In press, Working Group for Planetary System Nomenclature, *in* 20th General Assembly, Baltimore, 1988, Proceedings: International Astronomical Union Transactions, v. 20B.

Jordan, J.F., and Lorell, Jack, 1973, Mariner 9, an instrument of dynamical science: Paper presented at AAS/AIAA Astrodynamics Conference, Vail, Colo., July 16–18, 1973.

Kliore, A.J., Fjeldbo, Gunnar, Seidel, B.L., Sykes, J.J., and Woiceshyn, P.M., 1973, S-Band radio occultation measurements of the atmosphere and topography of Mars with Mariner 9: Extended mission coverage of polar and intermediate latitudes: Journal of Geophysical Research, v. 78, no. 20, p. 4331–4351.

Lindal, G.F., Hotz, H.B., Sweetnam, D.N., Shippony, Zvi, Brenkle, J.P., Hartsell, G.V., and Spear, R.T., 1979, Viking radio occultation measurements of the atmosphere and topography of Mars: Journal of Geophysical Research, v. 84, no. B14, p. 8443–8456.

Lorell, Jack, Born, G.H., Jordan, J.F., Laing, P.A., Martin, W.L., Sjogren, W.J., Shapiro, I.I., Reasenberg, R.D., and Slater, G.L., 1972, Mariner 9 celestial mechanics experiment: Gravity field and pole direction of Mars: Science, v. 175, no. 4019, p. 317–320.

Pettengill, G.H., Rogers, A.E.E., and Shapiro, I.I., 1971, Martian craters and a scarp as seen by radar: Science, v. 174, no. 4016, p. 1321–1324.

Pleskot, L.K., and Miner, E.D., 1981, Time variability of Martian bolometric albedo: Icarus, v. 45, no. 1, p. 179–201.

U.S. Geological Survey, 1985a, Shaded relief and surface markings of the eastern and western regions of Mars: U.S. Geological Survey Miscellaneous Investigations Series Map I–1535, scale 1:15,000,000.

———1985b, Shaded relief maps of the eastern, western, and polar regions of Mars: U.S. Geological Survey Miscellaneous Investigations Series Map I–1618, scale 1:15,000,000.

———1989, Topographic maps of the western equatorial, eastern equatorial, and polar regions of Mars: U.S. Geological Survey Miscellaneous Investigations Series Map I–2030, scale 1:15,000,000.

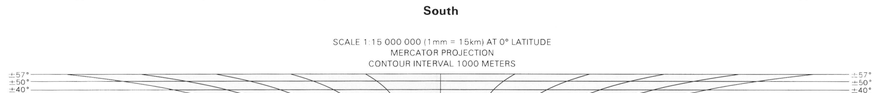
Wu, S.S.C., 1978, Mars synthetic topographic mapping: Icarus, v. 33, no. 3, p. 417–440.

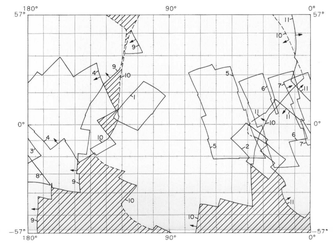
———1981, A method of defining topographic datums of planetary bodies: Annales de Geophysique, AGEPA 7, tome 37, fasc. 1, p. 147–160.

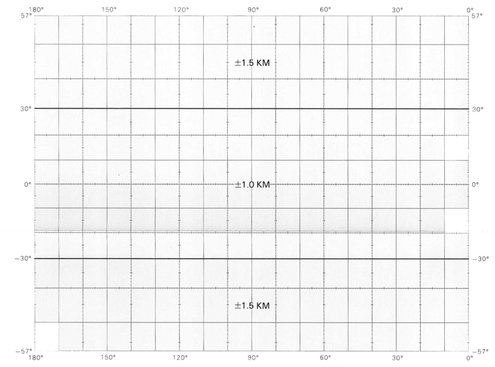
Wu, S.S.C., Elassal, A.A., Jordan, Raymond, and Schafer, F.J., 1982, Photogrammetric applications of Viking orbital photography: Planetary and Space Science, v. 30, no. 1, p. 45–55.

Wu, S.S.C., and Schafer, F.J., 1984, Mars control network: American Society of Photogrammetry, *in* Technical papers of the 50th annual meeting of the American Society of Photogrammetry, v. 2, Washington, D.C., March 11–16, 1984, p. 456–463.

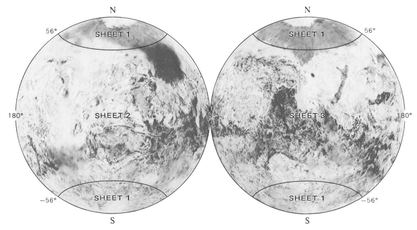
SCALE 1:15 000 000 (1mm = 15km) AT 0° LATITUDE
MERCATOR PROJECTION
CONTOUR INTERVAL 1000 METERS







INDEX MAP OF PROBABLE ELEVATION ERROR



INDEX TO THE 1:15,000,000 MAP SERIES

INDEX OF PRIMARY MAPPING SOURCES

Index No.	Picture No.	Index No.	Picture No.	Index No.	Picture No.	Index No.	Picture No.	Index No.	Picture No.
1	REV 583A	6	REV 666A		323S80		334S42		334S85
	583A14		666A25		323S81		334S44		334S86
	583A30		666A26		323S82		334S46		334S87
2	REV 586A		666A36		323S83		334S48		334S89
	586A25		666A45		323S84		334S50	11	REV 378S
	586A26		666A46		323S85		334S51		378S04
3	REV 609A		666A55		323S86		334S52		378S06
	609A45		666A56		323S87		334S54		378S13
4	REV 614A	7	REV 669A		323S88		334S55		378S14
	614A05		669A24	10	REV 334S		334S57		378S15
	614A06		669A47		334S01		334S59		378S35
	614A15		669A48		334S02		334S61		378S46
	614A16	8	REV 684A		334S03		334S63		378S47
	614A25		684A05		334S05		334S65		378S48
	614A26	9	REV 323S		334S07		334S67		378S49
	614A35		323S33		334S09		334S69		
	614A36		323S35		334S11		334S70		
	614A45		323S37		334S13		334S71		
	614A46		323S39		334S15		334S73		
	614A55		323S41		334S18		334S74		
	614A56		323S48		334S20		334S75		
5	REV 663A		323S49		334S22		334S76		
	663A05		323S53		334S24		334S77		
	663A06		323S71		334S26		334S78		
	663A15		323S73		334S28		334S79		
	663A16		323S75		334S30		334S80		
	663A25		323S76		334S34		334S81		
	663A26		323S77		334S36		334S82		
	663A35		323S78		334S38		334S83		
	663A36		323S79		334S40		334S84		

NOTE TO USERS

Users noting errors or omissions are urged to indicate them on the map and to forward it to U.S. Geological Survey, Building 4, Room 454, 2255 North Gemini Drive, Flagstaff, Arizona 86001. A replacement copy will be returned.

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1991

Revised on behalf of the Planetary Geology Program, Solar System Exploration Division, Office of Space Science, National Aeronautics and Space Administration, under contract W–15,814. Shaded relief map prepared under contract W–13,709
This map supersedes sheet 1 of I–1535
Manuscript approved for publication, February 16, 1990

TOPOGRAPHIC MAP OF THE WESTERN REGION OF MARS

M 15M 0/90 2AT

1991