

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared for the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NOTES ON BASE
This is one map in a series of topographic map sheets covering the entire surface of Mars at nominal scales of 1:25,000,000 and 1:5,000,000 (Batson, 1973). The major source of map data was the Mariner 9 television experiment (Marsurs and others, 1976).

ADOPTED FIGURE
The figure of Mars used for the computation of the map projection is an oblate spheroid (flattening of 1/192) with an equatorial radius of 3393.4 km and a polar radius of 3375.7 km.

PROJECTION
The Mercator projection is used for this sheet, with a scale of 1:5,000,000 at the equator and 1:4,336,000 at lat 30°. Longitudes increase to the west in accordance with usage of the International Astronomical Union (IAU, 1971). Latitudes are areographic (de Vaucouleurs and others, 1973).

CONTROL
Planimetric control is provided by photogrammetric triangulation using Mariner 9 pictures (Davies, 1973; Davies and Arthur, 1973) and the radio-tracked position of the spacecraft. The first meridian passes through the crater Airy-O (lat 5.19° S) within the crater Airy. No simple statement is possible for the precision, but local consistency is 5-10 km.

MAPPING TECHNIQUE
A series of mosaics of Mercator projections of Mariner 9 pictures was assembled at 1:5,000,000.

Shaded relief was copied from the mosaics and portrayed with uniform illumination with the sun to the west. Many Mariner 9 pictures besides those in the base mosaic were examined to improve the portrayal (Levinthal and others, 1973). The shading is not generalized and may be interpreted with photographic reliability (Inge, 1972).

Shaded relief analysis and representation were made by Patricia M. Bridges.

ALBEDO MARKINGS
The markings superimposed on the shaded relief were hand copied from pictures that were computer enhanced especially to show low frequency tone variation (Batson and Inge, 1976). The surface in these pictures is illuminated from a variety of angles from the camera line of sight. The markings therefore delineate boundaries of local brightness variations only and should not be considered as a true measure of albedo. No attempt was made to use Earth based telescopic albedo data.

Airbrush portrayal of albedo markings was done by Patricia M. Bridges.

CONTOURS
Since Mars has no sea and hence no sea level, the datum (the 0 km contour line) for altitudes 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 derived from radio-occultation data (Klone and others, 1973; Christensen, 1975). This datum is a triaxial ellipsoid with semi-major axes of A=3394.6 km, B=3393.3 km, and a semi-minor axis of C=3376.3 km. The semi-major axis A intersects the Martian surface at long 105°.

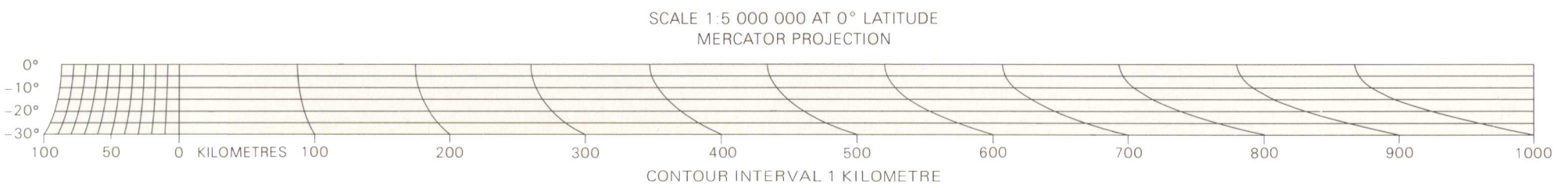
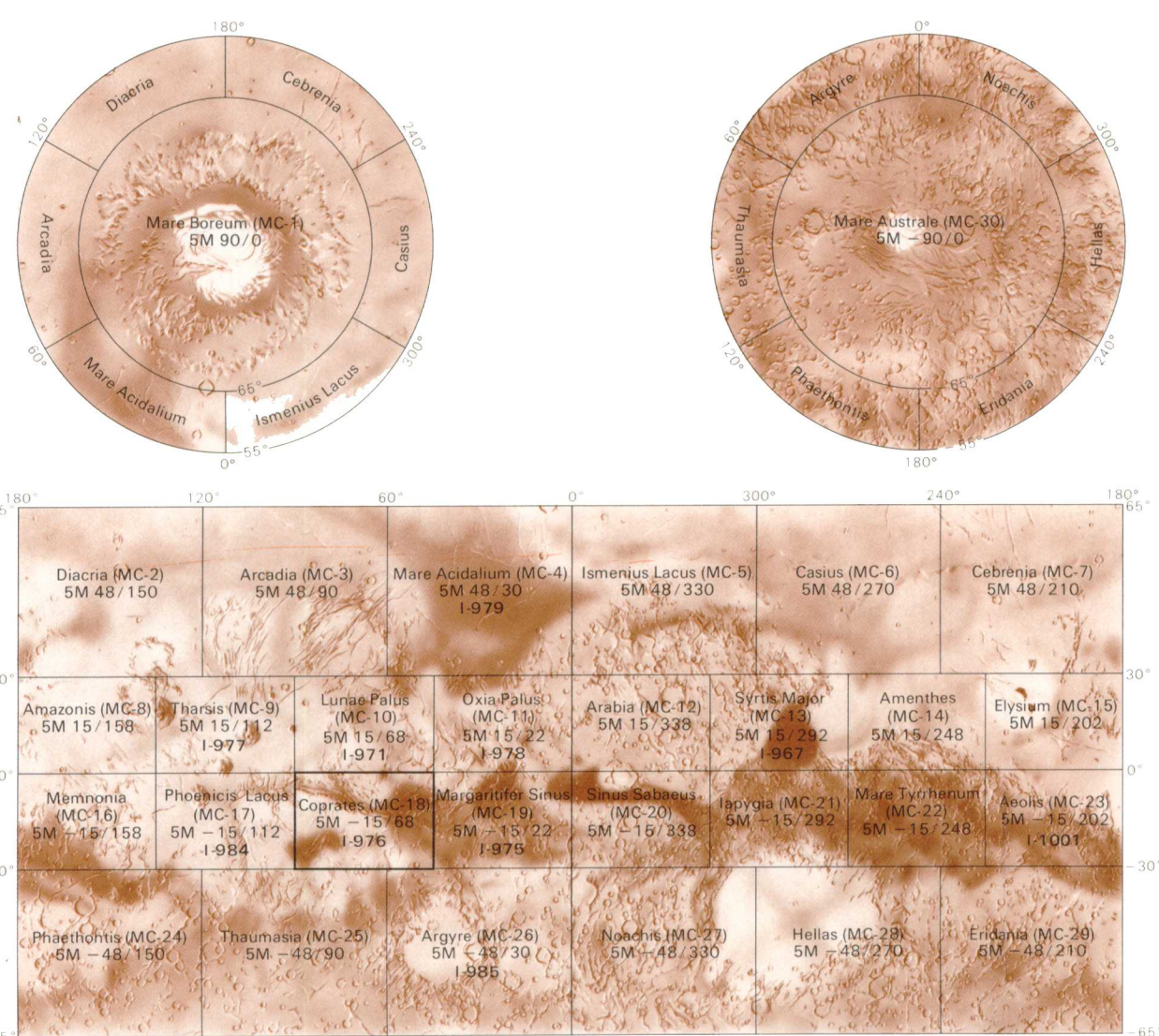
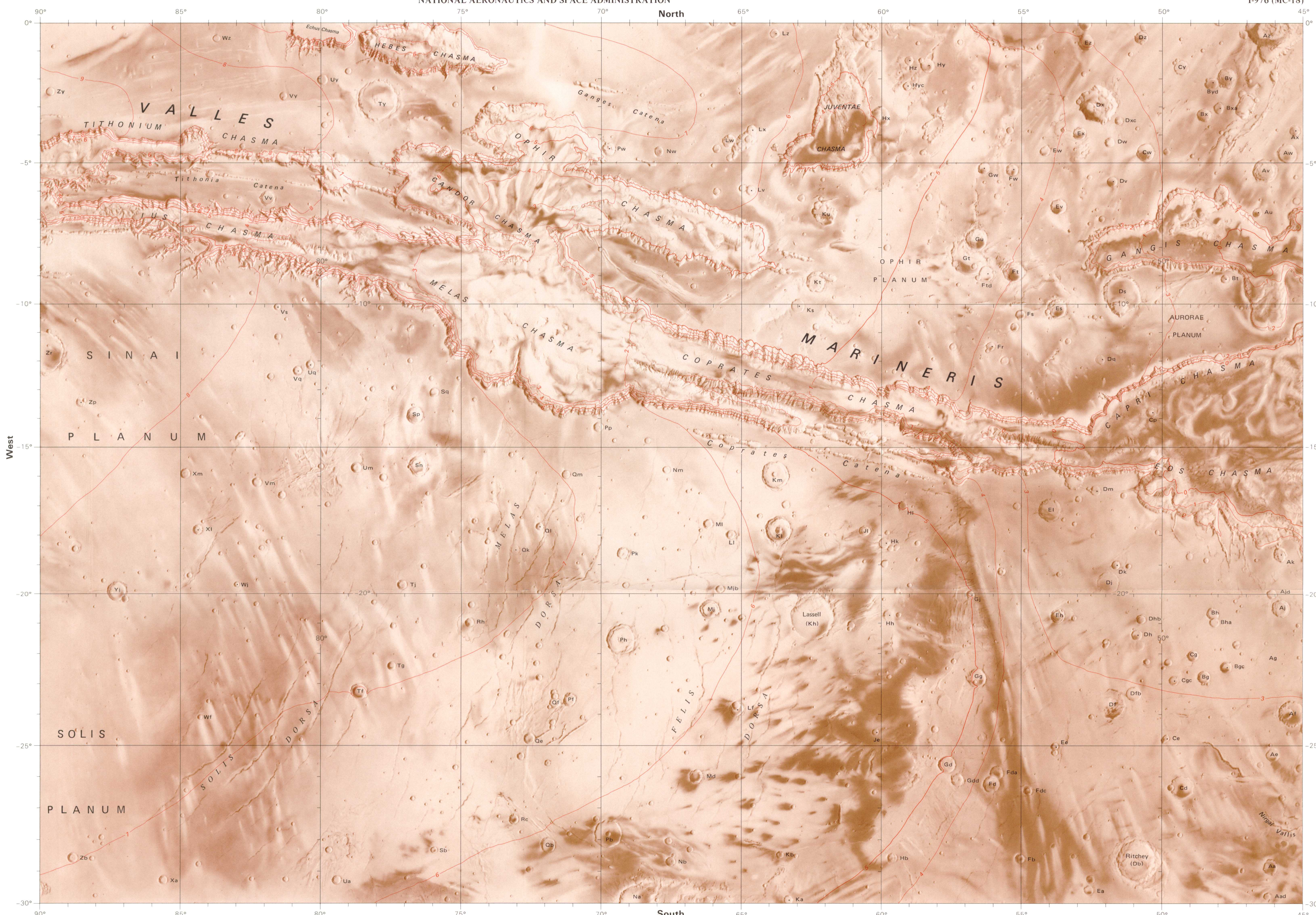
The contour lines (Wu, 1975) were compiled from Earth-based radar determinations (Downs and others, 1971; Pettengill and others, 1971) and measurements made by Mariner 9 instrumentation, including the ultraviolet spectrometer (Hord and others, 1974), infrared interferometer spectrometer (Conrath and others, 1973), and stereoscopic Mariner 9 television pictures (Wu and others, 1973). Formal analysis of contour-line accuracy has not been made. The estimated vertical accuracy of each source of data indicates a probable error of 1-2 km.

COLOR
No attempt was made on the map to precisely duplicate the color of the Martian surface, although the color used does approximate it.

NOMENCLATURE
All names on this sheet are approved by the International Astronomical Union (IAU, 1974; milliam, written common, 1975). Double and triple letter designations for craters refer to position on the map. Some craters have commemorative names; letter designations for these craters are shown in parentheses. Where craters lie mostly on an adjoining map, their letters are derived from the other map; where craters lie exactly on the boundary of two maps, their letters are derived from the eastern or southern map.

MC-18: Abbreviation for Mars Chart 18.
M 5M -15/68 RMC: Abbreviation for Mars 1:5,000,000 series; center of sheet, 15° S latitude, 68° W longitude; shaded relief map, R with albedo markings, M, and contours, C.

REFERENCES
Batson, R. M., 1973, Cartographic products from the Mariner 9 mission: Jour. Geophys. Research, v. 78, no. 29, p. 4424-4435.
Batson, R. M., and Inge, J. L., 1976, Albedo boundaries on Mars in 1972: Results from Mariner 9: Icarus, v. 27, no. 3 (in press).
Christensen, E. J., 1975, Martian topography derived from occultation, radar, spectral, and optical measurements: Jour. Geophys. Research, v. 80, no. 20, 2909-2913.
Conrath, B. J., Curran, R. K., Hanel, R. A., Kunde, V. G., Maguire, W. W., Pearl, J. C., Piragaglia, J., Welker, J., and Burke, T., 1973, Atmospheric and surface properties of Mars obtained by infrared spectroscopy on Mariner 9: Jour. Geophys. Research, v. 78, no. 20, p. 4267-4278.
Davies, M. E., 1973, Mariner 9: Primary control net: Photogramm. Eng., v. 39, no. 12, p. 1297-1302.
Davies, M. E., and Arthur, D. W. G., 1973, Martian surface coordinates: Jour. Geophys. Research, v. 78, no. 20, p. 4355-4394.
Downs, G. S., Goldstein, R. M., Green, R. R., and Morris, G. A., 1971, Mars radar observations, a preliminary report: Science, v. 174, no. 4016, p. 1324-1327.
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., 1972, Principles of lunar illustration: Aeronaut. Chart and Inf. Center Ref. Pub., RP-72-1, 60 p.
International Astronomical Union, Commission 16, 1971, Physical study of planets and satellites, in Proc. 14th General Assembly, 1970: Internat. Astron. Union Trans., v. XIVb, p. 128-137.
—, 1974, Physical study of planets and satellites, in Proc. 15th General Assembly, 1973: Internat. Astron. Union Trans., v. XVb, p. 105-108.
Jordan, J. J., and Lorell, Jack, 1973, Mariner 9, an instrument of dynamical science: Presented at AAS/AIAA Astrodynamics Conf., Vol. Colco, July 16-18, 1973.
Klone, A. J., Fjeldbo, Gunnar, Seidel, B. L., Sykes, M. J., and Woicesyn, 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: Jour. Geophys. Research, v. 78, no. 20, p. 4331-4351.
Levinthal, E. C., Green, W. B., Cutts, J. A., Jahlke, F. D., Johansen, R. A., Sander, M. J., Seidman, J. B., Young, A. T., and Soderblom, L. A., 1973, Mariner 9 image processing and products: Icarus, v. 18, no. 1, p. 75-101.
Masursky, Harold, Batson, R. M., Borgerson, W. T., Carr, M. H., McCauley, J. F., Milton, D. J., Willey, R. L., Williams, D. E., Murray, B. C., Horowitz, N. H., Leighton, R. B., Sharp, R. V., Thompson, T. W., Briggs, G. A., Chandeysson, P., Shipley, E. N., Sagan, Carl, Pollack, J. B., Lederberg, Joshua, Levinthal, E. C., Hartmann, W. K., McCord, T. B., Smith, B. A., Davies, M. E., de Vaucouleurs, G. D., and Leovy, C. B., 1970, Television experiment for Mariner Mars 1971: Icarus, v. 12, no. 1, p. 10-42.
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.
de Vaucouleurs, G. D., Davies, M. E., and Sturms, F. M., Jr., 1973, The Mariner 9 areographic coordinate system: Jour. Geophys. Research, v. 78, no. 20, p. 4395-4404.
Wu, S. S. C., Schafer, F. J., Nakata, G. M., Jordan, Raymond, and Blasius, R. R., 1973, Photogrammetric evaluation of Mariner 9 photography: Jour. Geophys. Research, v. 78, no. 20, p. 4405-4410.
Wu, S. S. C., 1975, Topographic mapping of Mars: U.S. Geol. Survey Interagency Rept. 63 (in press).



A-camera pictures				B-camera pictures			
Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.	Index No.	DAS No.
1	7327143	26	9017229	51	9068979	1	7327198
2	7329943	27	9090619	52	7688113	2	7326228
3	7417063	28	9614423	53	1218462	3	7399784
4	9128133	29	9090119	54	9160799	4	7398788
5	7429653	30	7688243	55	7688103	5	7417029
6	9262613	31	9090809	56	9090909	6	7426788
7	7814843	32	7614353	57	6211133	7	6139768
8	1009769	33	9017019	58	9017019	8	7426788
9	9889189	34	7542463	59	7542523	9	7542628
10	7810713	35	7410309	60	7398429	10	6139768
11	9817299	36	7470573	61	5973438	11	7614808
12	7398713	37	7410309	62	8841239	12	7614808
13	8945489	38	1291024	63	5981223	13	1049264
14	7398713	39	8841239	64	8841239	14	7614808
15	8841239	40	7398613	65	7398613	15	1049264
16	7398713	41	7326263	66	5426803	16	7614808
17	10206519	42	8129209	67	6129123	17	7614808
18	7326263	43	7326263	68	9016949	18	7326263
19	8129209	44	7398429	69	5254713	19	7398429
20	7326263	45	8873309	70	5598643	20	8873309
21	7398683	46	7470463	71	9090809	21	8873309
22	8841249	47	8841249	72	9160719	22	8873309
23	7470463	48	7542263	73	5624763	23	1291024
24	8945439	49	9017089	74	5389763	24	8873309
25	7542533	50	7614353			25	8873309

INDEX TO MARINER 9 PICTURES USED TO MAKE THE ALBEDO MARKINGS OVERLAY
Most of the pictures indexed above were specially processed to accentuate albedo markings. Only the useful image areas of the pictures are outlined.

INDEX TO MARINER 9 PICTURES
The mosaic used to control the positioning of features on this map was made with the Mariner 9 A-camera pictures outlined above. Useful coverage is not available in some cross-hatched areas. Pictures other than those shown in the mosaic were used for portrayal in the other cross-hatched areas. Also shown (by solid black rectangles) are the high-resolution B-camera pictures, identified by italic numbers.

TOPOGRAPHIC MAP OF THE COPRATES QUADRANGLE OF MARS

MC-18
M 5M -15/68 RMC
1976

For sale by Branch of Distribution, U.S. Geological Survey, 1209 South East Street, Arlington, VA 22202, and Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225.