

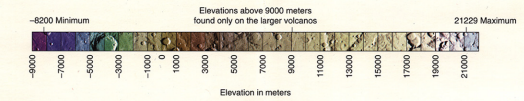
SCALE 1:15 196 708 (1 mm = 15,196,708 km) AT 90° LATITUDE
 POLAR STEREOGRAPHIC PROJECTION
 1000 500 0 500 1000 KILOMETERS
 NORTH POLAR REGION

NOTES ON BASE
 This map is based on data from the Mars Orbiter Laser Altimeter (MOLA; Smith and others, 2001), an instrument on NASA's Mars Global Surveyor (MGS) spacecraft (Albee and others, 2001). The image used for the base of this map represents more than 600 million measurements gathered between 1999 and 2001, adjusted for consistency (Neumann and others, 2001, 2003) and converted to planetary radii. These have been converted to elevations above the areoid as determined from a martian gravity field solution GMM-2B (Lemoine and others, 2001), truncated to degree and order 50, and oriented according to current standards (see below). The average accuracy of each point is originally ~100 meters in horizontal position and ~1 meter in radius (Neumann and others, 2001). However, the total elevation uncertainty is at least 3 m due to the global error in the areoid (11.8 meters according to Lemoine and others (2001)) and regional uncertainties in its shape (G.A. Neumann, written commun., 2002). The measurements were converted into a digital elevation model (DEM; G.A. Neumann, written commun., 2002; Neumann and others, 2001; Smith and others, 2001) using Generic Mapping Tools software (Wessel and Smith, 1998), with a resolution of 0.015625 degrees per pixel or 64 pixels per degree. In projection, the pixels are 926.17 meters in size at the equator. Data are very sparse near the two poles (above 87° north and below 87° south latitude) because these areas were sampled by only a few off-nadir altimetry tracks. Gaps between tracks of 1–2 km are common, and some gaps of up to 12 km occur near the equator. DEM points located in these gaps in MOLA data were filled by interpolation.

PROJECTION
 The Mercator projection is used between latitudes ±57°, with a central meridian at 0° and latitude equal to the nominal scale at 0°. The Polar Stereographic projection is used for the regions north of the +55° parallel and south of the -55° parallel with a central meridian set for both at 0°. The adopted equatorial radius is 3396.19 km (Duxbury and others, 2002; Seidelmann and others, 2002).

COORDINATE SYSTEM
 The MOLA data were initially referenced to an internally consistent inertial coordinate system, derived from tracking of the MGS spacecraft. By adopting appropriate values for the orientation of Mars as defined by the International Astronomical Union (IAU) and the International Association of Geodesy (IAG; Seidelmann and others, 2002), these inertial coordinates were converted into the planet-fixed coordinates (longitude and latitude) used on this map. These values include the orientation of the north pole of Mars (including the effects of precession), the rotation rate of Mars, and a value for W_0 of 176.630°, where W_0 is the angle along the equator to the east, between the 0° meridian and the equator's intersection with the celestial equator at the standard epoch J2000.0 (Seidelmann and others, 2002). This value of W_0 was chosen (Duxbury and others, 2002) in order to place the 0° meridian through the center of the small (~500 m) crater Airy-0, within the crater Airy (Seidelmann and others, 2002; de Vaucouleurs and others, 1973). Longitude increases to the east and latitude is planetocentric as allowed by IAU/IAAG standards (Seidelmann and others, 2002) and in accordance with current NASA and USGS standards (Duxbury and others, 2002). A secondary grid (printed in red) has been added to the map as a reference to the west longitude/planetographic latitude system that is also allowed by IAU/IAAG standards (Seidelmann and others, 2002) and has also been used for Mars. The figure adapted to compute this secondary grid is an oblate spheroid with an equatorial radius of 3396.19 km and a polar radius of 3376.2 km (Duxbury and others, 2002; Seidelmann and others, 2002).

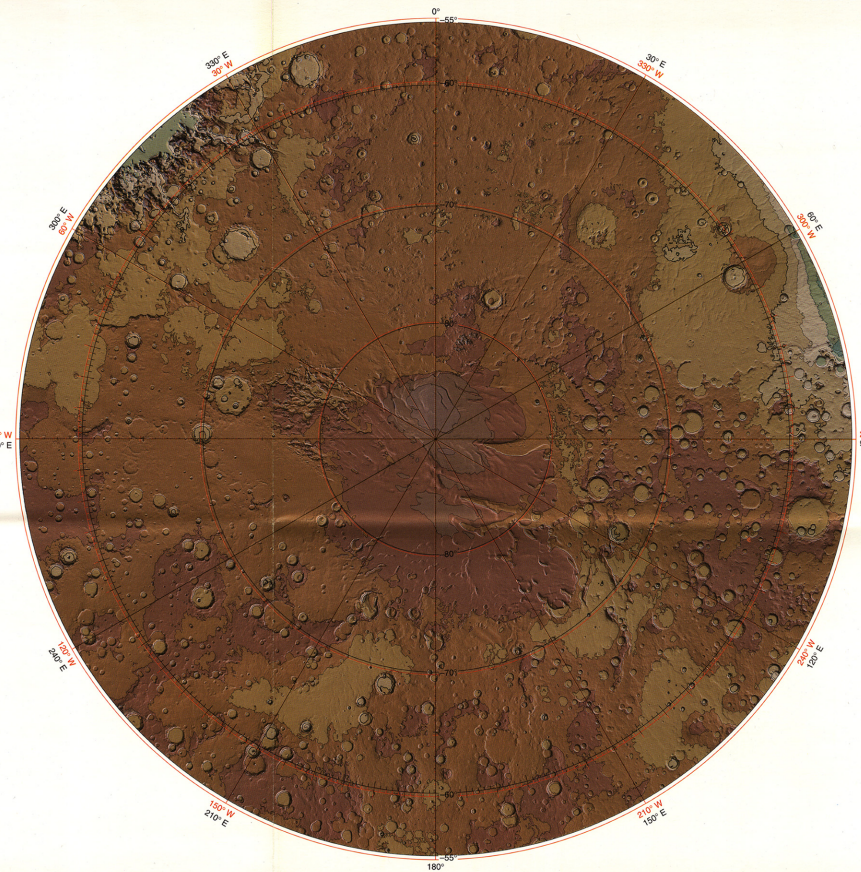
MAPPING TECHNIQUES
 To create the topographic base image, the original DEM produced by the MOLA team in Simple Cylindrical projection with a resolution of 64 pixels per degree was projected into the Mercator and Polar Stereographic pieces. A shaded relief was generated from each DEM with a sun angle of 30° from horizontal and a sun azimuth of 270°, as measured clockwise from north, and a vertical exaggeration of 100%. Illumination is from the west, which follows a long-standing



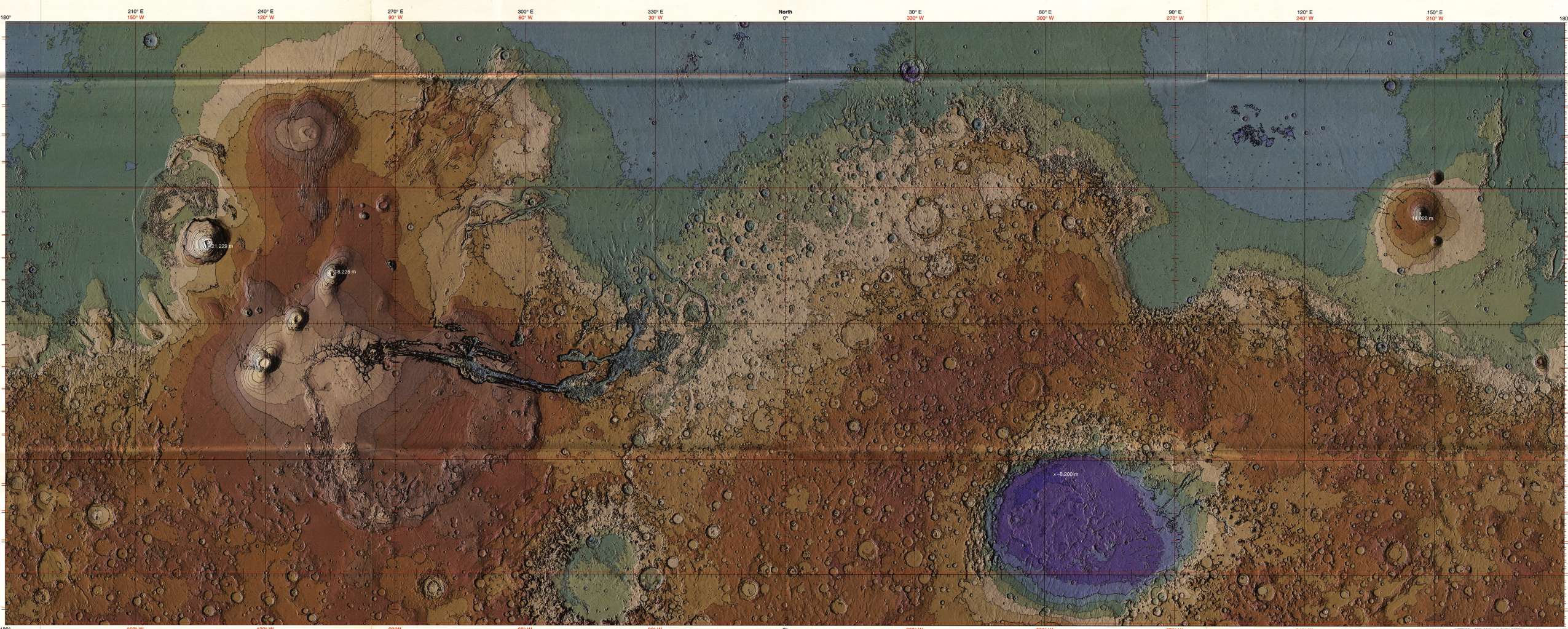
USGS tradition for planetary maps. This allows for continuity in the shading between maps and quadrangles, and most closely represents lighting conditions found on imagery. The DEM values were then mapped to a global color look-up table, with each color representing a range of 1 km of elevation. These two files were then merged and scaled to 1:25 million for the Mercator portion and 1:15,196,708 for the two Polar Stereographic portions, with a resolution of 300 dots per inch. The projections have a common scale of 1:13,923,113 at ±56° latitude. Contours were created from the DEM at a 1-kilometer interval. Contours for features with a diameter of 3 km or less (features too small for this map scale) were removed. The contours were then simplified by removing points along the contours spaced less than 1 km apart.

NOMENCLATURE
 M 25M RKT Abbreviation for Mars: 1:25,000,000 series, shaded relief (R), with color (K) and contours (T); Greeley and Batson, 1990

REFERENCES
 Albee, A.L., Arvidson, R.E., Pallacini, Frank, Thorpe, Thomas, 2001, Overview of the Mars Global Surveyor mission: Journal of Geophysical Research, v. 106, no. E10, p. 23,291–23,316.
 de Vaucouleurs, Gerard, Davies, M.E., and Sturms, F.M., Jr., 1973, Mariner 9 areographic coordinate system, in Journal of Geophysical Research, v. 78, p. 4395–4404.
 Duxbury, T.C., Kirk, R.L., Archinal, B.A., and Neumann, G.A., 2002, Mars Geodesy/Cartography Working Group recommendations on Mars cartographic constants and coordinate systems, in Joint International Symposium on Geospatial Theory, Processing and Applications, Ottawa, Canada, 2002 Commission IV, Working Group 9—Extraterrestrial Mapping, Proceedings: Ottawa, Canada, International Society for Photogrammetry and Remote Sensing (<http://www.isprs.org/commission4/proceedings/paper.html>).
 Greeley, Ronald, and Batson, R.M., 1990, Planetary mapping: Cambridge University Press, p. 274–275.
 Lemoine, F.G., Smith, D.E., Rowlands, D.D., Zuber, M.T., Neumann, G.A., Chinn, D.S., Pavlis, D.E., 2001, An improved solution of the gravity field of Mars (GMM-2B) from Mars Global Surveyor: Journal of Geophysical Research, v. 106, no. E10, p. 23,359–23,376.
 Neumann, G.A., Rowlands, D.D., Lemoine, F.G., Smith, D.E., and Zuber, M.T., 2001, Crossover analysis of Mars Orbiter Laser Altimeter data: Journal of Geophysical Research, v. 106, no. E10, p. 23,753–23,768.
 Neumann, G.A., Smith, D.E., and Zuber, M.T., 2003, Two Mars years of clouds observed by the Mars Orbiter Laser Altimeter: Journal of Geophysical Research (in press).
 Seidelmann, P.K. (chair), Abalakin, V.K., Bursa, Milan, Davies, M.E., De Bergh, Catherine, Lieske, J.H., Oberst, Juergen, Simon, J.L., Standish, E.M., Stooke, P.J., and Thomas, P.C., 2002, Report of the IAU/IAAG Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites—2000: Celestial Mechanics and Dynamical Astronomy, v. 82, p. 83–110.
 Smith, D.E., Sjogren, W.L., Tyler, G.L., Balmino, G., Lemoine, F.G., and Konopliv, A.S., 1999, The gravity field of Mars—Results from Mars Global Surveyor: Science, v. 286, p. 94–96.
 Smith, D.E., Zuber, M.T., Frey, H.V., Garvin, J.B., Head, J.W., Muhleman, D.O., Pirtengill, G.H., Phillips, R.J., Solomon, S.C., Zwally, H.J., Banerdi, W.B., Duxbury, T.C., Golombek, M.P., Lemoine, F.G., Neumann, G.A., Rowlands, D.D., Aharonson, Oded, Ford, P.G., Ivanov, A.B., Johnson, C.L., McGovern, P.J., Abshire, J.B., Afzal, R.S., and Sun, Xiaoli, 2001, Mars Orbiter Laser Altimeter—Experiment summary after the first year of global mapping of Mars: Journal of Geophysical Research, v. 106, no. E10, p. 23,689–23,722.
 Wessel, Paul, and Smith, W.H.F., 1998, New, improved version of Generic Mapping Tools released: Eos, Transactions of the American Geophysical Union, v. 79, no. 47, p. 579.



SCALE 1:15 196 708 (1 mm = 15,196,708 km) AT 90° LATITUDE
 POLAR STEREOGRAPHIC PROJECTION
 1000 500 0 500 1000 KILOMETERS
 SOUTH POLAR REGION



SCALE 1:25 000 000 (1 mm = 25 km) AT 0° LATITUDE
 MERCATOR PROJECTION
 2000 1000 500 0 500 1000 2000 KILOMETERS
 CONTOUR INTERVAL 1000 METERS
 Planetographic latitude and west longitude coordinate system is shown in red.
 Planetocentric latitude and east longitude coordinate system is shown in black.

Color-Coded Contour Map of Mars
 M 25M RKT
 By
 U.S. Geological Survey
 2003

NOTE TO USERS
 Users noting errors or omissions are urged to indicate them on the map and to forward it to the Astrogeology Team, U.S. Geological Survey, 2255 North Gemini Drive, Flagstaff, Arizona 86001. A replacement copy will be returned.

ISSN 0-107-81378-8
 9780607893786

Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.
 For sale by U.S. Geological Survey, Information Services, Box 25286, Federal Center, Denver, CO 80225, 1-800-486-1548
 Digital files available on World Wide Web at <http://geocubs.wr.usgs.gov>
 Printed on recycled paper