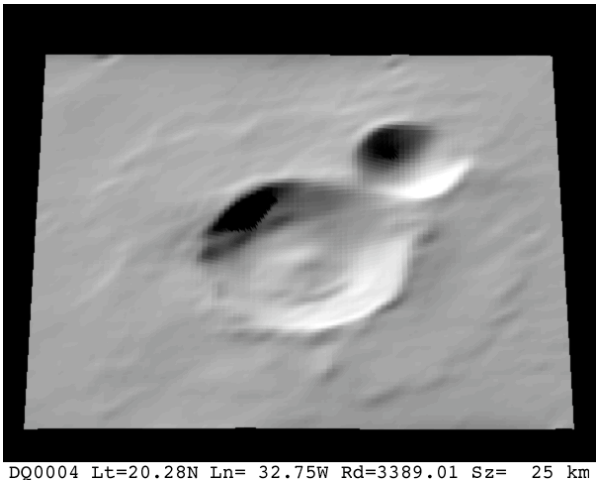
MAPPING MARS WITH LANDMARK TEMPLATES. R.W. Gaskell, JPL/Caltech, MS 301/150, 4800 Oak Grove Drive, Pasadena, CA 91109, (818) 354-2116, rwg@piglet.jpl.nasa.gov.

Introduction: Viking Orbiter, MOC and MOLA data are being used to construct three dimensional landmark templates on Mars which can be aligned with a variety of data types for navigation on future missions and which provide a characterization of the surface topography.



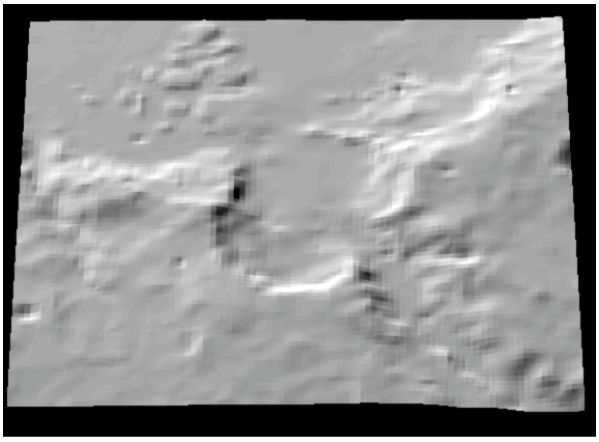
DQ0004 Lt=20.28N Ln= 32.75W Rd=3389.01 Sz= 25 km

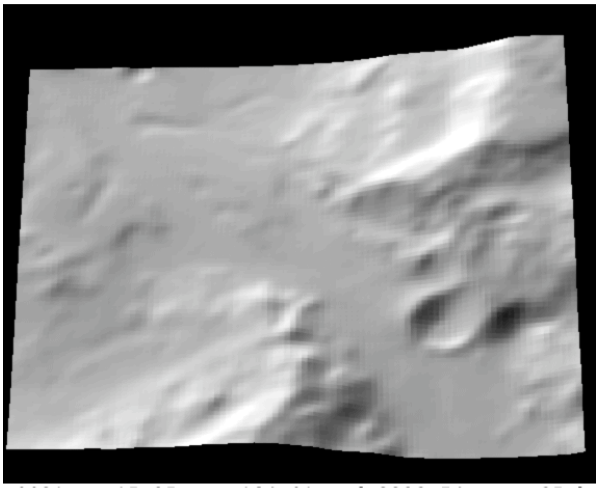
Each template is described by a vector from the center of Mars to the origin of a local coordinate system and by an array of heights and albedos relative to that system.

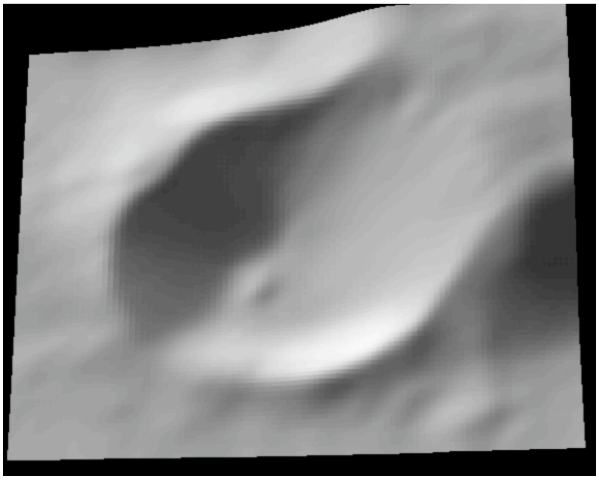
Template Construction: The landmark templates are constructed as part of a three-step cyclical iteration with each step supplying refined inputs for the next:

1. Images are registered (aligned), the central landmark vectors determined, and possibly the spacecraft vectors found, by minimizing the weighted mean square residuals between nominal and observed landmark locations, limbs, and overlapping landmark templates.
2. The surface gradient and albedo at each pixelized location within the landmark are determined by minimizing the mean square residuals between the re-illuminated model and imaging data extracted from a number of pictures.
3. The gradients are integrated to produce the height distribution in the landmark, with sparsely sampled heights from MOLA and overlapping maps included to provide an absolute height scale, and to prevent errors in the gradient solutions from propagating too far.

Photoclinometry: The determination of slopes and albedos depends upon relative rather than absolute photometry. The absolute height scale is set by external inputs such as large-scale slopes or curvature determined from stereography, from shadowing, or from laser altimetry. Essentially, combining high resolution optical data with large-scale topography from MOLA, for example, enables a detailed interpolation to a much smaller scale. The images below represent 1km resolution from MOLA and 250 and 50 meter resolution from photoclinometry.







The photometric function was chosen to be 2/3 Lommel-Seeliger and 1/3 Lambert.

Current Status: Although more than a thousand landmarks have been catalogued so far, they are by no means uniformly distributed. There are concentrations near past and potential landing sites, and large areas which have yet to be processed. In addition to adding landmarks in the sparser regions, THEMIS visible data is now being included to enable determination of topography at even smaller scales.

References:

R. Gaskell, "Automated Landmark Identification for Spacecraft Navigation," AAS paper 01-422, AAS/AIAA Astrodynamics Specialists Conf., August. 2001, Quebec City, PQ, Canada.

R. Gaskell, "Determination of Landmark Topography from Imaging Data," AAS paper 02-021, AAS/AIAA Astrodynamics Specialists Conf., March 2002, Breckenridge, CO.

R. Gaskell, "Three Dimensional Landmark Templates," 2002 AGU Fall Meeting , December 2002, San Francisco, CA.