THE TOPOGRAPHY AND BASIN DEPOSITS OF THE EQUATORIAL HIGHLANDS: A MGS–VIKING SYNERGISTIC STUDY. J. M. Moore[1], P. M. Schenk[2], and A. D. Howard[3], [1]NASA Ames Research Center, MS 245-3, Moffett Field, CA 94035, [2]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058, [3]Department of Environmental Sciences, University of Virginia, Charlottesville, VA 22903
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Introduction: One of the greatest unresolved issues concerns the evolution of Mars early in its history; during the time period that accretion was winding down but the frequency of impacting debris was still heavy. Ancient cratered terrain that has only been moderately modified since the period of heavy bombardment covers about a quarter of the planet's surface but the environment during its formation is still uncertain. This terrain was dominantly formed by cratering. But unlike on the airless Moon, the impacting craters were strongly modified by other contemporary surface processes that have produced distinctive features such as 1) dendritic channel networks, 2) rimless, flat-floored craters, 3) obliteration of most craters smaller than a few kilometers in diameter (except for post heavy-bombardment impacts), and 4) smooth intercrater plains. The involvement of water in these modification processes seems unavoidable, but interpretations of the surface conditions on early Mars range from the extremes of 1) the *"cold"* model which envisions a thin atmosphere and surface temperatures below freezing except for local hydrothermal springs; and 2) the *"warm"* model, which invokes a thick atmosphere, seasonal temperatures above freezing in temperate and equatorial regions, and at least occasional precipitation as part of an active hydrological cycle. The nature of hydrologic cycles, if they occurred on Mars, would have been critically dependent on the environment. The resolution of where along this spectrum the actual environment of early Mars occurred is clearly a major issue, particularly because the alternate scenarios have much different implications about the possibility that life might have evolved on Mars.

Objectives and Technique: The objectives of our investigation are two-fold: **(1)** We are producing high resolution Digital Terrain Models (DTM) of a number of regions within the equatorial martian highlands which are registered to accurate global control using Viking Orbiter camera stereo coverage combined with Mars Orbiter Laser Altimeter (MOLA) ground tracks. Either data set separately suffers from serious shortcomings that are overcome by the synergistic combination of the two. A DTM-producing auto-correlation process developed by one of us (Schenk) has been successfully applied to several test areas using Viking stereo data (Fig 1). We have successfully used this technique in an analysis of the South Polar region of Mars in support of the MVACS lander site selection activity[1]. Several of the near-equatorial localities for which Viking stereo data are available have been identified as high priority Mars Surveyor Program landing sites for 2001 and later.

(2) We are using our DTMs to evaluate the sequence and extent of various landform-modifying processes that have shaped the martian equatorial highlands using models that simulates these processes on a three-dimensional synthetic landscape. This modeling has been developed by one of us (Howard) and emulates the following processes: 1) cratering; 2) fluvial erosion and sedimentation; 3) weathering and mass wasting; 4) aeolian erosion and deposition; and 5) groundwater flow and groundwater sapping. The models have been successfully used to predict the evolution of terrestrial landscapes. The models provide explicit simulations of landform development and thusly predict the topographic evolution of the surface and final landscape form. Prior to the generation of our Viking-MOLA DTMs, the models are severely hampered by the lack of absolute regional *and* high resolution topographic information. This is a consequence of the complex interplay between high and low frequency topography on landform modification. With our DTMs we will be able to much more realistically evaluate the evolution of the cratered uplands of Mars. Results of this analysis have direct import to Mars Surveyor Program landing site selection and science.

Demonstration of Model: Fig. 2 is a typical saturation crater simulation starting from an initially flat landscape. Fig. 3 is a simulated cratered landscape superimposed upon an initial fractal topography that has a relief of the same order of magnitude as the depth of the largest craters. This simulates the effects of large-scale topographic features that might have formed, such as tectonic ridges or basin rings. Fig. 4 shows erosional modification of the cratered landscape of Fig. 2 by a combination of mass wasting, fluvial erosion, and sediment deposition. All surface materials are assumed to be equally erodible, that is, they are either loose or are weatherable at a rate that keeps pace with erosion. Inner crater rims suffer the greatest amount of erosion, and locally become gullied. Relatively few large channels develop because of the restrictive assumption that no depression is drained. The overall drainage density thus appears to be very low. Crater floors fill in with low-gradient alluvial fans, obscuring small craters on the floors of larger ones. All these characteristics are common on the Martian cratered terrain. Figure 5 shows erosional modification of the hilly cratered terrain in Fig. 3. In contrast to Fig. 4, strong dissection occurs on regional slopes, producing well-developed divides and valleys.

Initial Study Areas: We have selected two areas for our initial studies: 1) the south edge of the "hematite" deposit detected by TES[2] and observed to be bordered by scarps and knobs exhibiting layers in Viking[3] and MOC SPO images located at ~2°S, 4°W; and 2) an enclosed basin into which several channels terminate at ~2°N, 240.5°W. Both regions were optimally imaged by Viking for the generation of DTMs, lie within the Mars 2001 landing constraints, and are potential locations for fluvial or lacustrine deposits. At the conference, we will present our analysis of these two localities.

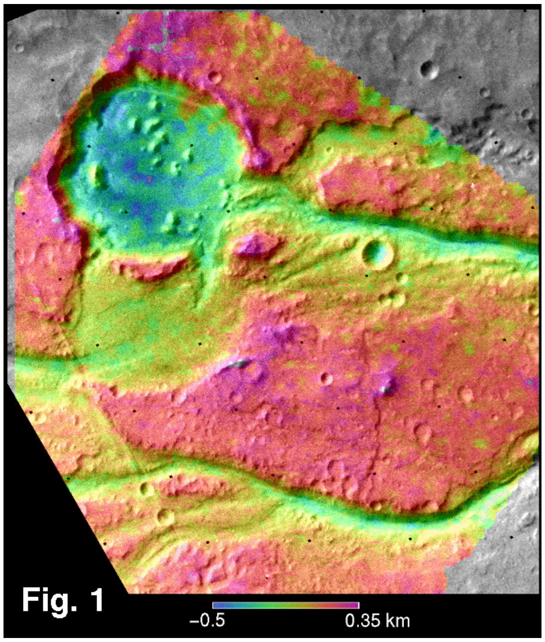

Fig. 1. Viking stereo-based DTM of the Vedra Valles region. Data were generated by an automated stereogrammetric package (see text) and have a contour interval of ~10 m and a horizontal resolution of 40 m. Topographic data have been used to color-code a Viking image mosaic of this region.

Figs. 2 through 5. Synthetic Martian surfaces showing the modeled effects of several geologic process. The geologic process show here are a subset of the range of processes that can be evaluated by the model used in this work. See text for details.

References:

[1] Schenk, P.M. and J.M. Moore. (1999) Stereo topography of the South Polar region of Mars: Volatile inventory and Mars Polar Lander landing site. submitted to *JGR*. [2] Christensen, P.R. *et al.*, (1999) *LPS XXX* CD, LPI, Houston, abs. #1461. [3] Edgett, K.S. and T.J. Parker (1997) *GRL*, *24*, 2897-2900.