STEREOGRAMMETRIC MAPPING ON MARS: PROMISE, PROGRESS, AND PROBLEMS.
P. M. Schenk[1] and J.M. Moore[2], [1]Lunar and Planetary Institute, Houston TX 77058 (schenk@lpi3.jsc.nasa.gov), [2]NASA Ames Research Center, Moffett Field CA 94035 (jmoore@mail.arc.nasa.gov).

Introduction: To assist in landing site selection, we are compiling a suite of stereo images of potential landing sites for the 1998 and 2001 Mars landers. From these, we are using automated stereogrammetry software to map the topography of these sites at higher resolution than previously available. One our tasks is to integrate stereo-based topography with MGS MOLA laser-based topography. These two data sets compliment each other and can lead to a higher level of understanding of Mars than would use of either dataset by itself. In this presentation, we report on the success of these efforts, and some of the lessons learned.

Promise: While MOLA will provide extremely well-controlled high-precision topographic data over the surface of Mars, aerial coverage is limited by the number of ground tracks over which data can be taken. Significant gaps of up to several kilometers are expected between pole-to-pole ground tracks. High spatial resolution topography can be produced from Viking and MOC stereo images, but these maps have poorer vertical resolution than MOLA and are difficult to control geodetically. Used together, the two data sets can compensate for the inadequacies of either data set alone.

Progress (South Polar Region): In anticipation of the launch of Mars Polar Lander in 1999, we located and prepared stereo image mosaics of the residual ice and layered deposits at the South Pole of Mars [1]. Despite problems (see below), we were able to produce topographic maps of roughly 50% of the region south of 70°S (Figs. 1, 2). These data show a 3-km-high, 500-km-wide topographic dome offset from the rotational pole and a broad dissected plateau 1 to 1.5 km high corresponding to the layered deposits [1]. Initial MOLA results over this same area (M. Zuber, pers. comm. 1999) confirm the basic stereo topographic results. We have begun stereogrammetric mapping in other candidate sites (as reported at the 5th Mars Conference [2]). This report will focus on the more advanced south polar work. We also report on our efforts to integrate MOLA laser topography with stereogrammetric topography.

Problems: Use of stereogrammetry in itself presents a host of problems as applied to Mars. Until release of the MGS Geodesy campaign data, Viking stereo remains the primary stereo database for Mars. Viking stereo data is very inconsistent in quality and quantity over the globe, with vertical resolution ranging from meters in a very few locations to over 1 km in others. Most areas are covered at ~50 to a few hundred meters vertical resolution (R. Kirk, pers. comm.).

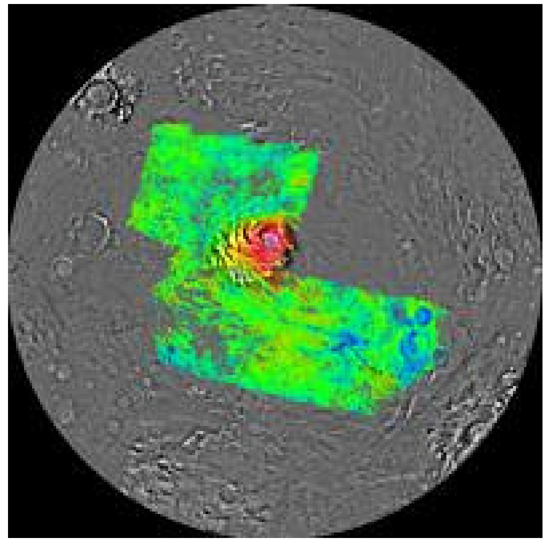

Figure 1. Topographic map of South Polar region of Mars. Stereogrammetric data derived from Viking stereo images [1]. Red is high, blue is low; gray areas contain no elevation data.

Figure 2. Topographic profile across the South Polar Dome on Mars. At left are smooth plains, at right are layered deposits. Profile runs top to bottom across the center of Figure 1.

Geometry and Geodesy: In some cases, line dropouts occur throughout the frame, distorting the mapped locations of reseau points, which are used to correct geometric distortion. Failure to do so correctly will warp the resulting topographic map produced from such stereo images. Geodetic control of individual Viking stereo pairs is difficult due to persistent errors in the current control net of Mars. This can result in uncertainties in regional slope estimates using stereo-derived data, unless alternative topographic control points are available (e.g., the occultation results of Smith and Zuber [3]). Local slope estimates are not as seriously affected. This problem is exacerbated when one attempts to merge separate but overlapping DTMs. We anticipate that control problems will be reduced by the results of the geodesy campaign.

Image Fidelity: The scene recognition algorithm our software is based on can be adversely affected by the quality of Viking images used. Vidicon noise is the most persistent problem. The level of inherent noise in the 4 Viking cameras appears to have been different. Line dropouts can distort the shape of landforms (due to line replication).

Lastly, there is the problem of Mars itself. At typical Viking stereo image resolutions of 100-300 m/pixel, the inherent contrast of the surface of Mars can be rather subtle, almost to the point of appearing featureless. This problem is enhanced by the fact that the images were returned as 7-bit rather than 8-bit data, further reducing contrast. Finally, some images used in Viking stereo pairs were acquired at different times of the Mars' year, integrating seasonal surface changes into a stereo mosaic. Such products can be quite useful for mapping out the migration of dust on Mars but interfere locally with the ability to map topography. The MGS Geodesy campaign, if successful in acquiring a global stereo database, may eliminate many of these problems. Despite these difficulties, we find that the combination of altimetry and stereo topography is a powerful tool for the geologic and morphologic study of features and regions on Mars.

[1] Schenk, P., and Moore, J. (1999) *J. Geophys. Res.* in press. [2] Moore, P., and Schenk., P. (1999) *5th Int'l Mars Conf* (abs.). [3] Smith, D., and Zuber, M. (19960 *Science*, 271, 184.