

HIGH-RESOLUTION TOPOGRAPHY OF LAYERS IN THE VALLES MARINERIS VIA 'THERMOCLINOMETRY'. L. Gaddis, L. Soderblom, R. Kirk, and T. Titus, U.S. Geological Survey, Astrogeology Program, 2255 N. Gemini Drive, Flagstaff, AZ (lgaddis@usgs.gov).

Introduction: This study addresses the use of high-resolution topographic data and morphologic analyses to study the origin of interior layered deposits in the Valles Marineris (**Figure 1**). These deposits are examined in part because they allow us to look into the geologic past of Mars and to study ancient depositional environments. Also, western portions of the VM have relatively high hydrogen abundance, and water may have played a significant role in the formation of layers in the canyon walls and floors there. Detailed studies of the topography, morphology, coherence, and continuity of layered deposits in the VM may allow us to assess the importance of water in their formation.

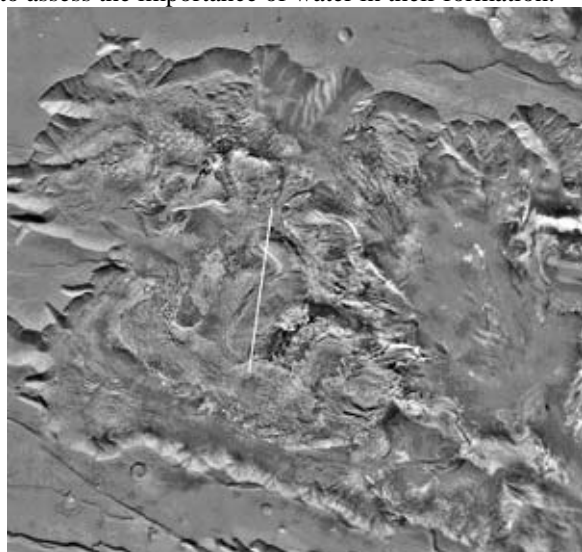


Figure 1. High-resolution VO mosaic of West Candor Chasma. Spatial resolution is ≤ 50 m. A white line (~ 70 km) marks the location of THEMIS data ground track (Figs. 2 and 3).

Approach: The method used was developed by Soderblom and Kirk [1-3] for deconvolution of THEMIS data into images and maps of thermophysical and topographic properties. This method uses simultaneously acquired THEMIS daytime visible (VIS) and infrared (IR) images of a given area, and THEMIS nighttime IR images of the same region. This 'thermoclinometric' method uses simple band math to isolate and separate albedo and thermal inertia effects from the topographic component of a scene, and then applies photoclinometric and thermal modeling to estimate and remove atmospheric effects and derive a high-resolution digital elevation model. It is assumed for this application to VM layered deposits that both the atmosphere and the thermal inertias of the layered units are uniform across the scene. If the latter as-

sumption is violated, then THEMIS IR data at multiple times of day can be used to isolate and examine unit characteristics [3]. The VM is well covered by THEMIS data, and it is expected that ~ 20 layered features (**Figure 2**) can be analyzed with these methods.

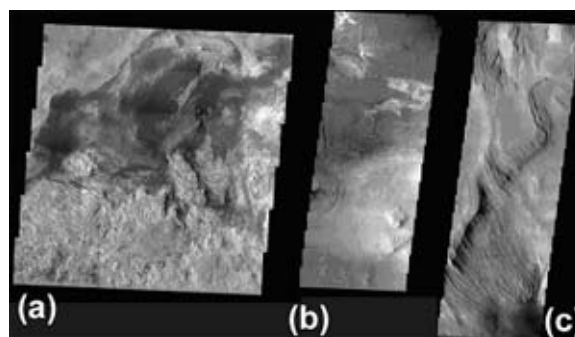


Figure 2. THEMIS VIS (band 3) views of the VM: (a) dark deposits in West Candor (V01776002), (b) dark eroded (but coherent) deposit in floor of Melas (V01601003), and (c) dark materials flowing down from a wall layer into the floor of Ophir (V01364002).

This method has been applied to a layered unit in the floor of West Candor Chasma of the VM (**Figure 1**). This unit is near Ceti Mensa (or 'Red Mesa'), a region that has been cited as the location of a possible hydrothermal site in West Candor [4]. For this application, MOLA data were used to derive photometric and scattering properties of the surface and atmosphere and a 2-D photoclinometric model was then forced to match the MOLA topography. The result is a detailed topographic model (**Figure 3**) of this layered deposit in VM, with low-frequency topography derived from MOLA data and high-frequency, high-resolution topography from the THEMIS data. This model for the layered deposit in the floor of West Candor shows relatively massive layered units that are coherent and of \sim uniform thickness over distances of several tens of km.

An interim product of this process is a "bedrock" map of a given unit, with thermal inertia effects and albedo separated out. The process is geometrically controlled by MOLA topography data (231 m/pixel grid) that is spatially coregistered to the THEMIS data. The horizontal resolution of the derived topographic image is ~ 80 m, which is adequate for spatial characterization of many layered deposits in the VM.

Because the derived topographic image is tied to the MOLA base and because the albedo and thermal inertia effects have been separated out, the derived topographic model can be used to extract detailed topog-

raphic data for a given illuminated region on Mars for which such coincident and simultaneous THEMIS data are available. Where derivation of detailed topographic models may not be possible in VM (e.g., where coincident/simultaneous THEMIS VIS and IR data are not available, or illumination conditions cause excessive shadowing), additional geomorphologic analyses of interior layered deposits in VM will focus on the use of THEMIS VIS, MOC, and Viking Orbiter (merged with MOLA) to examine and map detailed geologic and morphologic relations.

Analysis and Future Work: At present (in advance of drilling or penetrator efforts), layered deposits in canyon, channel, and crater walls may provide the best exposures of subsurface geologic units on Mars and thus the best means of characterizing geologic processes that have operated in Mars' past. The goal of this work is to constrain the origin and distribution of layers in the VM, and emphasis is placed on observations and measurements that will help to con-

strain a volcanic versus sedimentary origin for the layered deposits. Analyses of derived high-resolution topographic data for VM interior layered deposits will allow us to extract quantitative information on layer thickness and horizontal extent, and on dips of beds on local and regional scales. We aim to distinguish flat-lying layers from regionally dipping layers, to characterize interbedded units of variable albedo and coherence, to identify possible volcanic or eolian mantling deposits (that may have highly irregular thicknesses), and to distinguish flow units with possibly massive boundaries. We will use ISIS to display and extract quantitative information from the high-resolution topographic models, along with 3-D visualization and analysis tools in ArcView and ArcMap to perform these analyses.

References: [1] Soderblom and Kirk, LPSC XXXIV, #1730, 2003. [2] Soderblom et al., LPSC XXXIII, #1254, 2002. [3] Kirk et al., PERS, submitted 2004. [4] Geissler et al., *Icarus*, 106, p. 380, 1993.

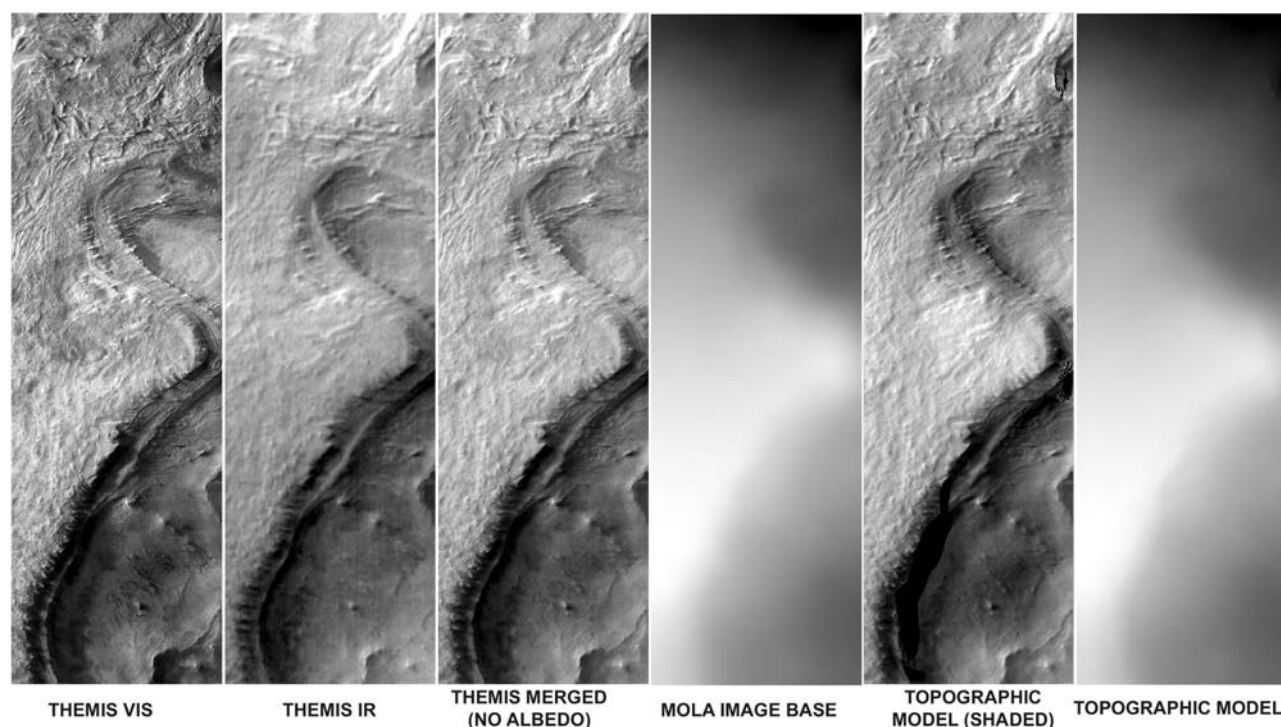


Figure 3. Deconvolution of THEMIS data and derivation of a high-resolution topographic model (at right). These data for a layered deposit in West Candor Chasma of the Valles Marineris show relatively massive layered units that are coherent and of ~uniform thickness over distances of several tens of km.