COUPLING VIKING INFORMATION WITH THEMIS AND MOLA DATA RESULTS IN SIGNIFICANT IMPROVEMENT IN PALEOEROSIONAL DETAIL OF WARREGO VALLES

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Introduction: Quantitatively, how much of an improvement in paleoerosional detail is there when THEMIS [1] and MOLA [2] data are coupled with Viking information [3]? This is a significant query, as there have been numerous Viking-based efforts to unfold the paleoerosional history of Mars, which is recorded in the distribution and relative age of channels and valley networks [e.g.,4-5]. We report preliminary findings on the re-evaluation of the Viking-based, published geologic map information of the Thaumasia region [3] through detailed investigation of the Warrego rise region, which includes Warrego Valles (**Figs. 1 and 2**).

The Warrego rise region is a prominent part of the ancient Thaumasia highlands mountain range, with an elevation of more than 7.6 km above Martian datum. The rise occurs on the southern margin of the arcuate mountain range, which is marked by magnetic signatures [e.g., 6-10], complex tectonic structures [3,11-14], and well-defined valley networks of Warrego Valles [3-5,15-16] (**Fig. 2**). Warrego rise has been identified as a regional center of tectonic activity [17].

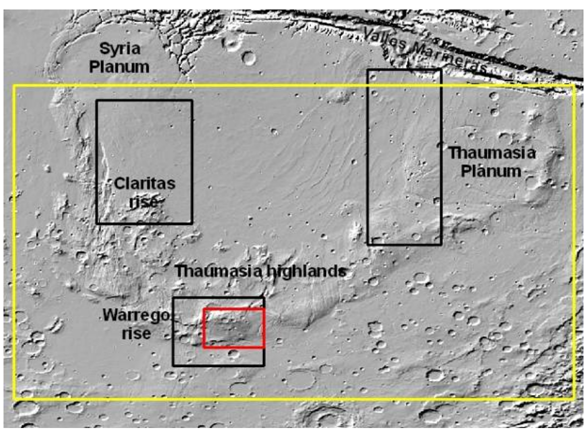

Fig. 1. Locations of detailed mapping of the Warrego rise region using THEMIS and MOLA for comparison with the published Viking-based geologic map data of [3] (red box marks the location of **Fig. 2**). The highlighted region is 1 of 3 regions (black boxes) under re-evaluation (also see [19-20] which details comparison results of the geologic information of the Claritas rise and the Thaumasia Planum regions). Also shown is the Thaumasia region that was mapped using Viking data (yellow outline) based on [3]. Warrego rise is a distinct promontory along the south-central margin of the Thaumasia highland mountain range.

Geologic evidence indicates that Warrego rise may have developed as a result of Late Noachian-Early Hesperian magmatic activity [3,17-18]. Evidence for magmatic-driven activity includes nearby volcanoes, fault and rift systems, collapse pits and depressions, and Late Noachian and Early Hesperian faults that appear deflected about the rise (interpreted to mark an intrusive body at depth which deflected extensional faults about its central core) [3]. Hydrothermal activity [3,15] and precipitation [3,16] have been proposed for valley formation.

Approach: Channels and valley networks have been identified and mapped on the THEMIS IR map base using Viking (MDIM), THEMIS (both daytime and nighttime), and MOLA data compile using GIS software (**Fig. 2**). This contrasts with the Viking-based geologic map units and erosional features that were identified and mapped on individual, digitally enhanced Viking images and 1:2,000,000-scale photomosaic bases and compiled on the 1:5,000,000-scale digital photomosaic map base using pen and mylar (**Fig.2**). THEMIS IR resolution for the Thaumasia region is 100 m/pixel. Supportive mapping information included THEMIS VIS images with an approximate resolution of 18 m/pixel and gridded MOLA topography at 463m/p.

GIS-based evaluation allows us to quantitatively assess whether there is a change in the geologic detail when THEMIS and MOLA data are coupled with Viking information. Here, for example, detailed paleoerosional information newly compiled for the Warrego rise region using the three data types can be compared to Viking-based information [3] of the same region. This includes total number of channels and valleys, total length of channels and valleys, and channel/valley-length densities (sum of all feature types divided by the total area of Viking-based geological units mapped by [3] that pertain to a specific stage of major geologic activity of Tharsis; see [3] and [21] for further explanation and Fig. 2 and Table 1).

Channel/ Valley stage	Total area of map units per Stage (km^2)	Channel/Valley Total (Viking; Reevaluated)	Total Channel/Fault length (km)	Density ($km/10^2 km^2$)
1	6.9%	0; 2	0;24.8	0.0/1.0
2	72.1%	470; 492	3431.5; 5884.5	14.0/24.0
3	21.0%	30; 44	671.9; 592.9	9.42/8.3

Table 1. Comparison between the Viking- [3] and newly mapped VIKING/THEMIS/MOLA-based Channel/Valley network information.

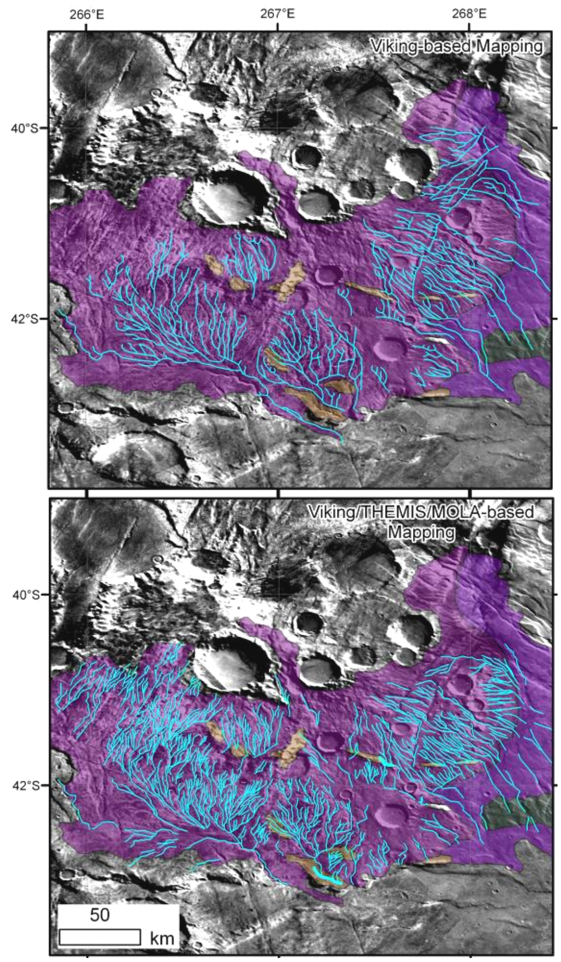

Fig. 2. Viking-based geologic information on Viking base (top; map information based from [3], including geologic contacts that delineate geologic map units and channels and valley networks (blue lines) and Viking/THEMIS/MOLA-based paleoerosional information on THEMIS day-time mosaic (bottom; newly mapped channels and valley networks shown in blue) for comparative analysis using GIS to quantify improvement in geologic detail.

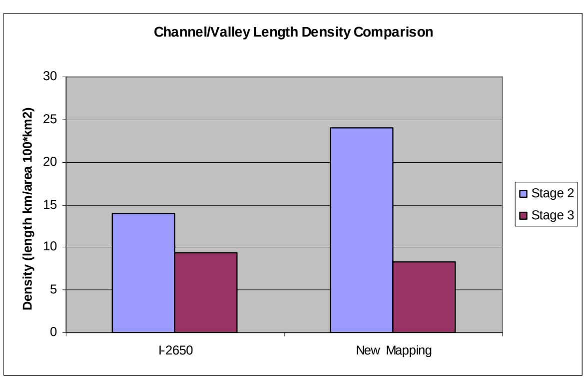

Figure 3. Histograms comparing Viking- [3] and newly mapped VIKING/THEMIS/MOLA-based stage 2 and 3 channel/valley-length densities.

Results and Implications: Preliminary highlights include: (1) an increase in the total number and total length of channels and valley networks; (2) an increase in channel/valley-length densities for stages 1 and 2, (3) in several cases, Viking-mapped erosional features were revised; this includes improved differentiation of channels and valley networks; (4) THEMIS and MOLA resulted in enhanced detail, which includes improved assessment of stratigraphic and cross-cutting relations among map units and paleoerosional structures; (5) multiple data types allow for greater geologic perspective and thus greater accuracy in geologic mapping and related interpretation based largely on factors such as scale, structural orientation, look direction of the acquired image, sun angle, atmospheric conditions, etc.

Results from the ongoing investigation will have a direct bearing on the geologic evolution of Mars, since the Thaumasia region records geologic features and materials that span the recorded geologic history of Mars. This includes a reevaluation of the processes that shaped the landscape of Mars, which includes hydrologic and hydrogeologic activity of the Warrego rise region of Mars.

References: [1] Christensen, P.R. et al., 2003, *Science*, 300, 2056-2061. [2] Smith, D.E. et al., 1998, *Science*, 279, 1686–1692. [3] Dohm, J.M. et al., 2001a, *USGS Misc. Inv. Ser. Map I-2650*, scale 1:5,000,000. [4] Scott, D.H. et al., 1995, *USGS Misc. Inv. Ser. Map I-2461* (1:30,000,000). [5] Tanaka, K.L. et al. 1998, *J. Geophys. Res.*, 103, 407–31,419. [6] Acuña, M.H. et al., 1999, *Science*, 284, 790-793. [7] Acuña, M.H. et al., 2001, *J. Geophys. Res.*, 106, 23,403-23,417. [8] Connerney, J.E.P. 1999, *Science*, 284, 790-793. [9] Connerney, J.E.P. et al., 2005, *Science*, 102, 14970–14975. [10] Arkani-Hamed, J. 2003, *J. Geophys. Res.*, 108, doi:10.1029/2003JE002049. [11] Grott, M. et al., 2005, *Geophys. Res. Lett.*, 32, L21201, doi:10.1029/2005GL023894. [12] Grott, M. et al., 2007, *Icarus*, 186, 517-526. [13] Hauber, E., Kronberg, P., 2005, *J. Geophys. Res.*, 110, E07003, doi:10.1029/2005JE002407. [14] Anguita, F. et al., 2006, *Icarus*, 185, 331-357. [15] Gulick, V.C., Baker, V.R., 1989, *Nature*, 341, 514–516. [16] Ansan V., Mangold N., 2006, *Planetary and Space Science*, 54, 219-242. [17] Anderson R.C., et al., 2001, *J. Geophys. Res.*, 106, 20,563-20,585. [18] Dohm, J.M. et al., 2001b, *J. Geophys. Res.*, 106, 32 943-32 958. [19] Dohm, J.M., and Hare, T.M., 2007, *LPSC 38, Abstract #1403*. [20] Dohm, J.M., and Hare, T.M., 2007, *LPSC 39, Abstract #1935*. [21] Dohm, J.M. et al., 2001b, *J. Geophys. Res.*, 106, 32 943-32 958.